Illuminating Engineer

XXVIII. January, 1935 Price

COILED-COIL FILAMENT LAMPS

THE COILED-COIL LAMP represents the greatest advance in lamp manufacture for the past twenty years. Owing to reduction in heat losses up to 20% more light is available for the same cost and the same current consumption. Coiled-coil lamps are made by the manufacturers of the following brands of lamps:—

COSMOS
CRYSELCO
EDISWAN
MAZDA
OSRAM
SIEMENS

NEW LIGHTING FOR CHARING CROSS ROAD

THE lighting in Charing Cross Road has just been greatly improved. Centrally hung gas lamps, each giving a light of more than 2000 candle-power, have taken the place of the sidewalk lamps. The spacing between each lamp is 88 feet, giving a perfectly even light of over 1 foot-candle at the test points.

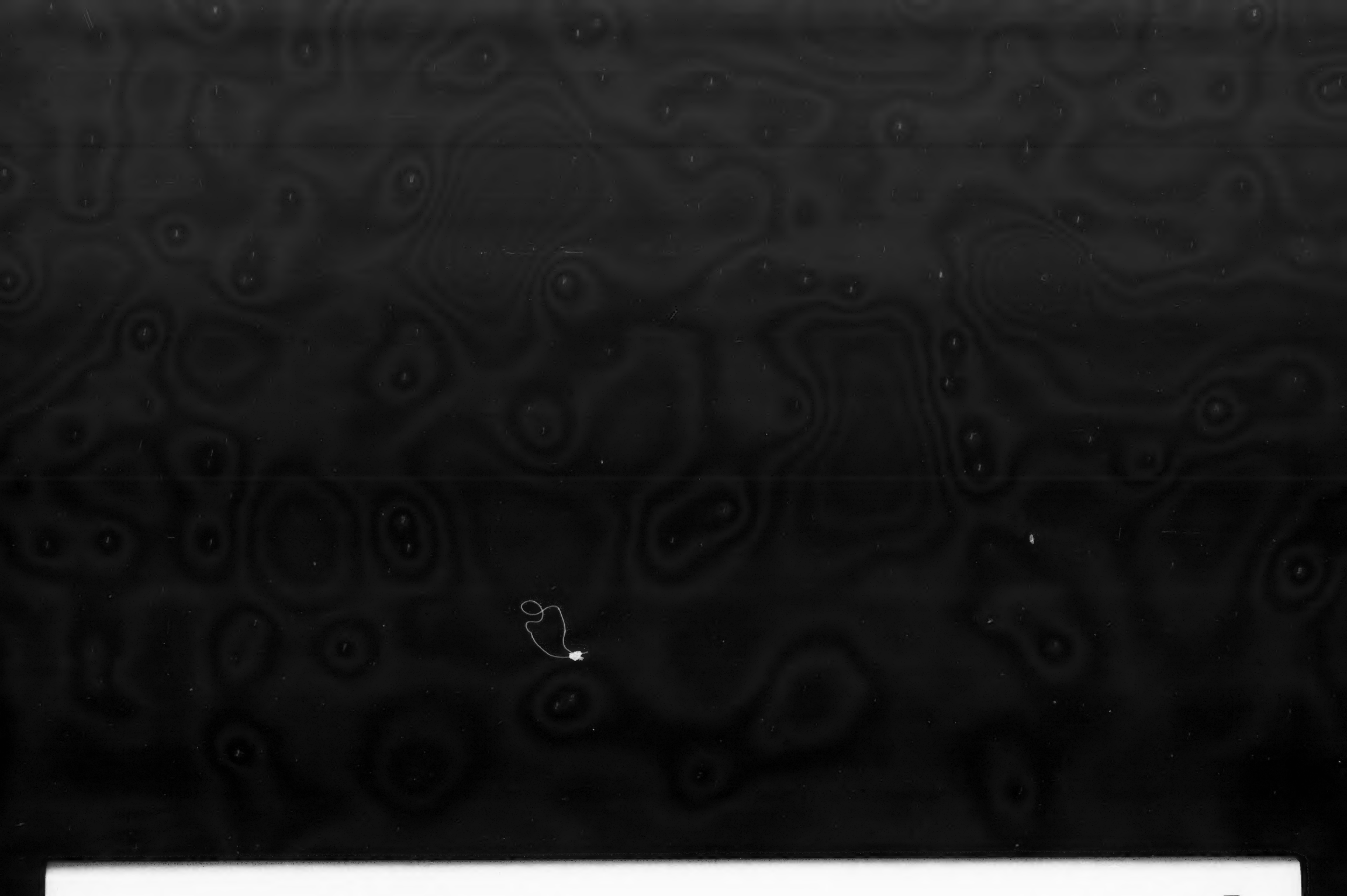
Good lighting is essential here, because this is one of the busiest streets in the West End. There is a constant flow of traffic up till one or two o'clock in the morning.

Several Councils have recently renewed agreements with this Company to keep their streets bright every night with gas lighting. They appreciate its cheapness and reliability.

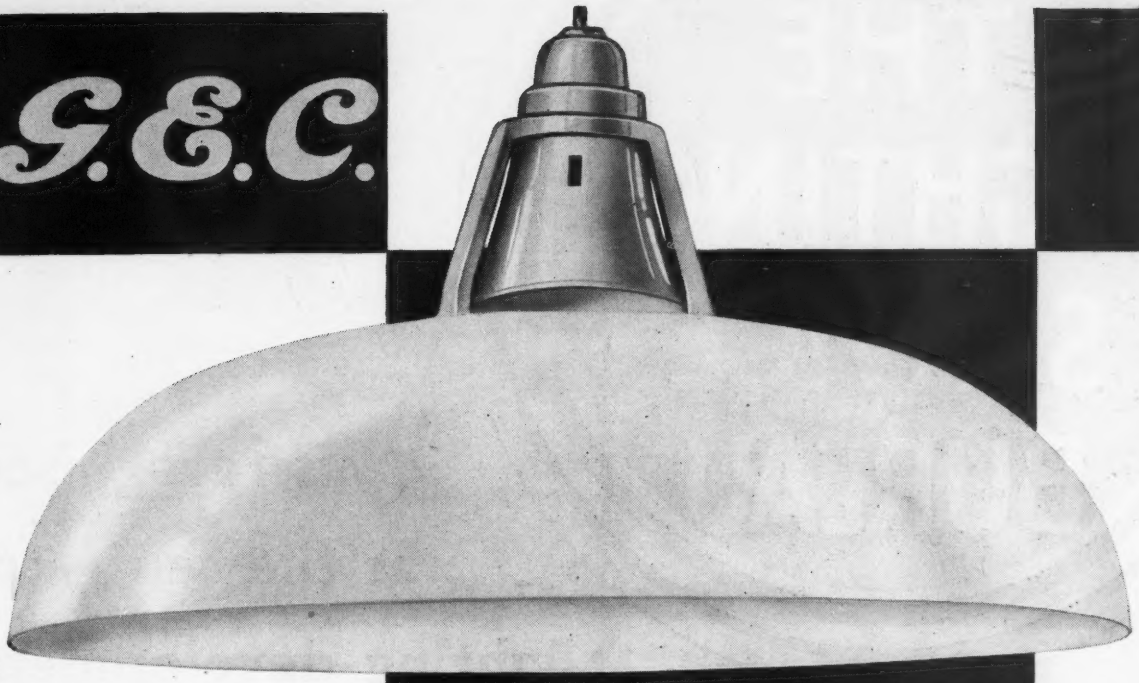
Gas used for public lighting during last year increased by 2.4% in the area of:—

THE GAS LIGHT & COKE COMPANY—*never lets London down*

Head Office: HORSEFERRY ROAD, S.W.1. VIC. 8100



G.E.C.



The OPAL Coolicon REGD.

Regd. design. Patents pending. Made in England

The Latest Lighting Improvement

MADE IN TWO SIZES
9″ and 11″ DIAMETER
WHITE, CHAMPAGNE,
PINK and PALE GREEN
PRICES FROM 2/9 EACH

A scientifically designed opal glass reflector giving correct distribution of light, plus the advantages of the patented Coolicon canopy strap. This avoids excessive heating of the lampholder, and also permits a portion of the light to pass upwards and illuminate the ceiling.

The old-fashioned conical and other light-wasting shades are superseded by this new reflector, which gives vastly better lighting at small cost.

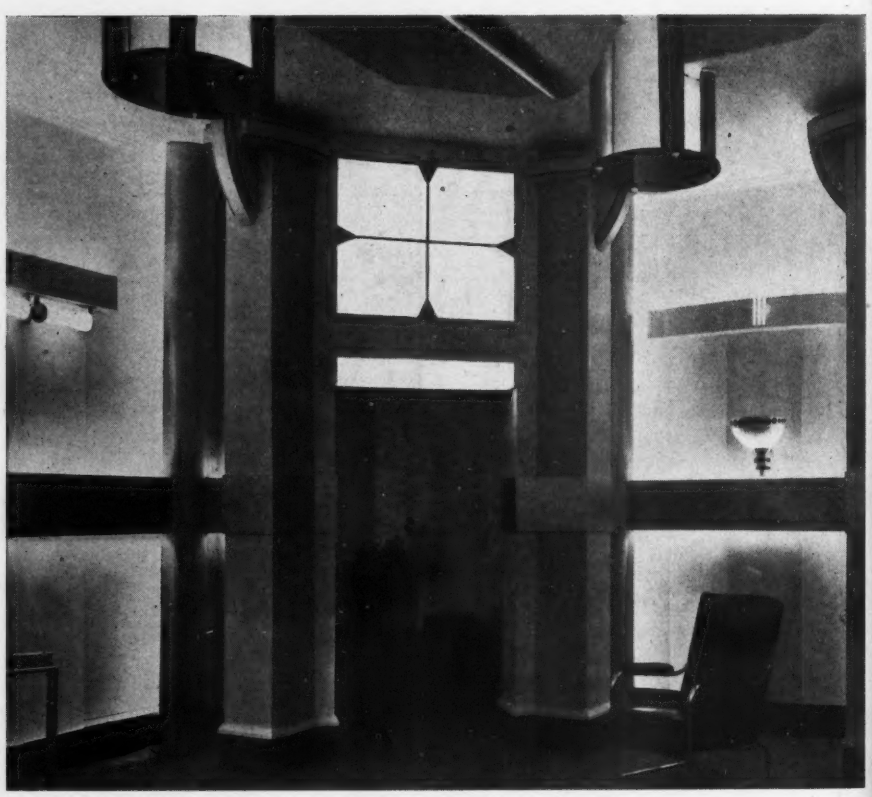
The Opal Coolicon is of light weight, and equally suitable for brass or bakelite lampholders, ordinary or skirted type. The ideal shade for all places where an inexpensive reflector of high lighting value and good appearance is desired.

Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

THE LIGHTING SERVICE BUREAU

is recognised as the centre of lighting development

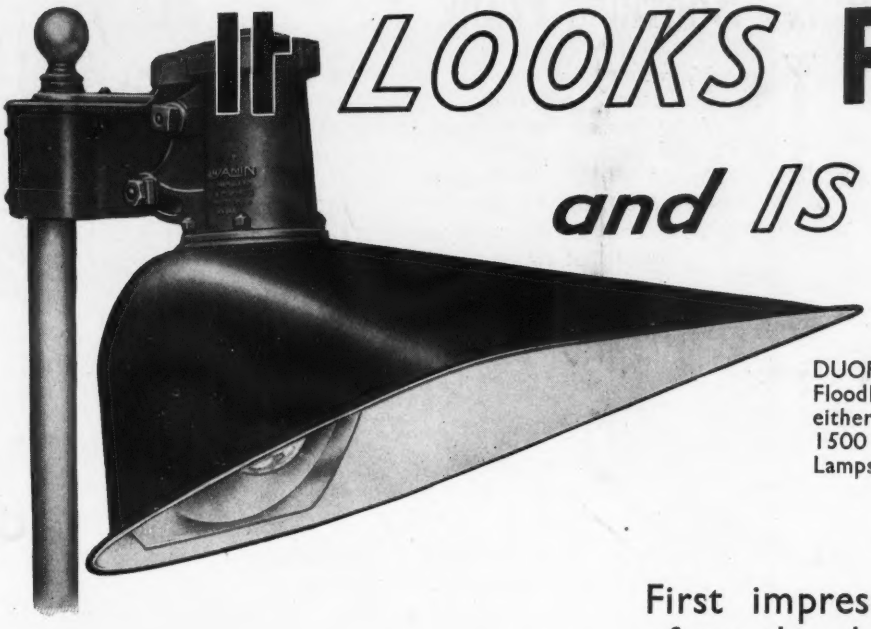
The new Architectural Lighting Room at the Lighting Service Bureau in which architects and lighting engineers may study ten new lighting systems, most of which can be applied to existing buildings.



The E.L.M.A. Lighting Service Bureau is maintained by the manufacturers of the following

British Made Lamps: COSMOS · CRYSELCO EDISWAN · MAZDA · OSRAM · SIEMENS

It LOOKS Right and IS right!



DUOFLUX — a Spotlight and Floodlight in one, for use with either gasfilled lamps (300 to 1500 watts) or Electric Discharge Lamps (250 and 400 watts).

First impressions are very often the best. The very appearance of the DUOFLUX floodlight conveys an unmistakable impression of efficiency which is more than confirmed by its actual performance. It *looks* right and *is* right for the floodlighting of Garages, Service Stations, Swimming Pools, Sports Arenas, Goods Yards, andcertain Industrial applications.

A typical DUOFLUX Installation at Wood Green Open Air Baths—an unretouched night photograph.

DUOFLUX combines a spreading flood with a directive beam and prevents all wasted upward light by redirecting it in a useful direction. The large area reflecting surface of the famous CRYSTEEL vitreous enamel—the efficient auxiliary reflector of anodised aluminium—the sturdy hood and mounting bracket, and finally its efficiency as an economical lighting unit—all contribute to make DUOFLUX the outstanding floodlight of to-day.

BENJAMIN DUOFLUX REGD.

The economical **FLOODLIGHT**

ADVERT. OF THE BENJAMIN ELECTRIC LTD., BRANTWOOD WORKS, TOTTENHAM, LONDON, N.17

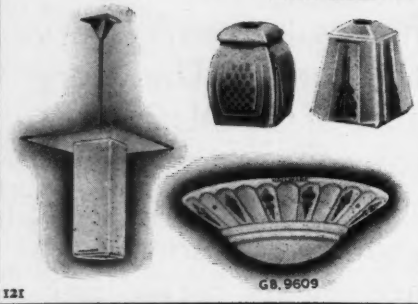
"HAILWARE" *is* "SOOTHING-WARE"!

If, when gout makes you grovel and cringe,
After having indulged in a binge,
You'd forget your despair,
Get the latest "Hailware"!
Your contentment will conquer that twinge.

Sole Makers:

HAILWOOD & ACKROYD, Ltd.,

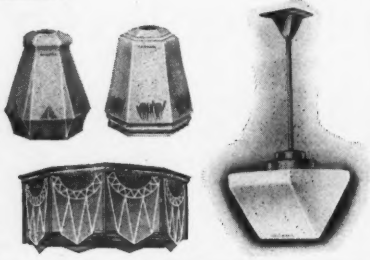
BEACON WORKS, MORLEY, Nr. LEEDS.



The designs illustrated are only a few of the almost innumerable designs illustrated in our leaflets, copies of which will be gladly sent on request.

Branches and Showrooms:
71/75, New Oxford St., London, W.C.1
314½, St. Vincent Street, Glasgow, C.3
Carlton House,
28, High Street, Birmingham, 4

Ulster Agents—**Messrs. Bell & Hull,**
17, College Street, Belfast, Ireland.



121

TYPE 3A/UNI
GAS CONTROLLER
15 DAY RUN

35/42 day run to order.
For "Square" Lanterns.

Automatic lighting

We offer a complete automatic lighting service, embracing both gas controllers and electric time switches.

Careful thought and experience in design, the best of British workmanship and materials, allied to the most up-to-date production and inspection methods, result in the utmost efficiency from Newbridge auto-lighters.

Many thousands are installed in all parts of the world, and satisfied users will gladly testify to the excellent results achieved.

Save the capital cost of converting indoor lighting to electricity by installing
NEWBRIDGE
Positive distance
GAS SWITCHES
—
Write for details.

NEWBRIDGE

GAS CONTROLLERS
ELECTRIC TIME SWITCHES
They sell because they excel

Let us submit samples for test under actual working conditions, together with quotation and catalogue.

THE HORSTMANN GEAR COMPANY LTD., Newbridge Works, BATH

• STIMULATING THE USE OF LIGHT

UNITED STATES LINES (HEAD OFFICE FOR PASSENGERS)
HAYMARKET, S.W.1.
Architect: J. Knox Vinycomb, F.R.I.B.A.

G.V.D. Pendants are suspended above the three laylights

CONTROLLED LIGHT

is the title of the G.V.D. Catalogue, a copy of which will gladly be sent upon request.

G.V.D
ILLUMINATORS, LIMITED

ALDWYCH HOUSE - - LONDON, W.C.2

Telephone : Holborn 8879

An interesting sequel to the introduction of the G.V.D. System of Illumination is the ***increasing use*** of light.

Architects, consulting engineers and consumers find that laylights, pillar, panel and cornice lighting are no longer an extravagant luxury, but an economic possibility even in the most modest buildings. Briefly, the advantages of this System are:—

GREATLY REDUCED COST OF INSTALLATION
without sacrifice of accessibility.

SUBSTANTIALLY LOWER COST OF RUNNING AND MAINTENANCE
combined with greater uniformity of lighting.

ELIMINATION OF SPECIAL VENTILATION
owing to reduction of heat.

ECONOMY OF SPACE
—laylights or cornice units can be constructed to a maximum depth of 12 inches.

The field of pendant lighting, too, has benefited by the introduction of a range of high-efficiency units.

MORE LIGHT
from
THE POPULAR PAIR

SIEMENS
COILED-COIL
PEARL OR OPAL LAMPS
ARE NOW AVAILABLE IN THE FOLLOWING SIZES —
AT NO EXTRA COST

MADE IN ENGLAND

Obtainable wherever Electric lamps are Sold.

40 WATT (200-260 VOLTS) GIVING	20%	MORE LIGHT
60 " " "	15%	
75 " " "	12½%	
100 " " "	10%	

AS COMPARED WITH OUR ORDINARY PEARL OR OPAL LAMPS
ALSO AVAILABLE IN CLEAR BULBS.

Address of SIEMENS ELECTRIC LAMPS AND SUPPLIES LIMITED. 38/39, Upper Thames Street, London, E.C.4.
Branches at-Belfast, Birmingham, Bristol, Cardiff, Dublin, Glasgow, Leeds, Liverpool, Manchester, Newcastle-on-Tyne, Nottingham, Sheffield, Southampton

Official Journal of THE ILLUMINATING ENGINEERING SOCIETY
FOUNDED IN LONDON 1909 INCORPORATED 1930

The ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

Edited by

J. STEWART DOW

Official Journal of THE ASSOCIATION of PUBLIC LIGHTING ENGINEERS
FOUNDED 1923 INCORPORATED 1928

Vol. XXVIII
January, 1935

Price NINEPENCE
Subscription 10/6 per annum, post free

EDITORIAL AND PUBLISHING OFFICES
32 VICTORIA STREET, LONDON, S.W.1
Tel. No: Victoria 5215

Principal Contents:

	PAGE
Editorial Notes	1
I.E.S. Meetings	3
Illumination by Electricity	4
Industrial Lighting	5
Lighting-Up Times	14
Lighting Literature	15
Patents	17
Illumination Charts	18
Modern Street Lighting	22
Trade Directory	28

Good Lighting—The Worker's Need

MR. DANIEL'S recent paper (see pp. 5-14) on Industrial Lighting made history. It was the first paper to be discussed in succession at meetings of the Illuminating Engineering Society in two areas (London and Manchester).

The paper also broke new ground by dealing critically with the industrial lighting of a single city. The really deplorable conditions reported in Sheffield were at their worst in the so-called tenement factories. But as visitors to the International Illumination Congress (1931) were surprised to learn, inferior lighting also prevails in many large and famous works.

In this last respect Sheffield is probably no worse than many other industrial cities. The depression has been blamed for these conditions. But much of this lighting is at once inefficient and wasteful. It might often be possible to give better light and yet to make a saving in the bill (though we do not say that really adequate lighting could be so obtained).

Conditions such as those reported by Mr. Daniel should surely not be allowed to exist. They would soon become a thing of the past if the long awaited statutory requirement of adequate lighting were incorporated in the Factory Acts.

Specifications of Illuminating Glassware

Revisions of two British Standard Specifications—No. 324—1934 Translucent (Diffusing) Glassware Illumination Fittings for Interior Lighting (superseding No. 324—1928); and No. 364—1934 Neck and Flange Dimensions of Illumination Glassware and Carriers (superseding No. 364—1929)—have just been issued. Both are of considerable importance to illuminating engineers. It will be recalled that No. 324 specifies a limit to brightness (five candles per sq. inch) and also prescribes tests of light output ratio and thermal endurance. Incidentally, instructions for the measurement of brightness are given in an Appendix. (How many makers of lighting fittings, one wonders, are completely familiar with methods of defining and measuring brightness or are aware of the convenient formula by the aid of which measurements in apparent foot-candles may be converted into candles per square inch?) The dimensions specified in the other specification are likewise of great importance in relation to standard sizes of electric lamps and gas mantles, and their publication should help materially towards bringing about the desired uniformity in practice.

Illuminated Signs and Traffic

At a recent Court of Common Council of the City of London, the danger of confusion to traffic being caused by illuminated signs in streets was discussed. In one sense any very bright or striking moving sign, by distracting the attention of motorists, is liable to cause danger. The confusion discussed in this case, however, was rather that due to the use of red, green and yellow light, i.e., the colours of traffic signals. The Court decided that it was impracticable to limit the use of illuminated signs by traders on their own buildings. Nevertheless, it does seem to us that some degree of control is becoming necessary. This is a matter which the Ministry of Transport might well consider. One form of luminous indication that certainly is desirable is that to reveal safe-crossings for pedestrians. We notice that the Minister of Transport recently intimated his willingness to consider proposals for the erection of pedestrian-operated light signals, and also for the illumination of the famous "beacons" by night. Certainly, visibility in darkness would seem to be the very first requirement in a beacon.

Dangers of Unskirted Lamp-Holders

H.M. Senior Electrical Inspector of Factories, in a Report recently issued, mentions that the total reported electrical accidents in factories in 1933 numbered 346, of which twenty-five were fatal. It is remarked that the actual number of such accidents during the past ten years has remained almost stationary, notwithstanding the greatly increased number of factories coming under the Electricity Regulations. This is doubtless due in a great measure to the effect of Regulations on design. An instance is afforded by the ordinary screw-cap lamp-holder, which, if unprovided by a protective skirt, may prove a source of danger. In one typical case reported half an inch of metal cap was exposed when the lamp was screwed in. To obtain better light in another part of the shed the lamp was lowered. A workman, standing on damp material, then walked several yards with the lamp in his hand, received a shock, and ultimately died. The switch was in the "off" position, and the lamp was not lighted at the time and was, therefore, assumed to be safe. Investigation showed, however, that the switch was of the single pole type and connected to the earthed neutral wire instead of the live wire. Other combinations of switching and wiring may bring about equally dangerous conditions. Hence the advisability of safe skirted types of lamp-holders, mentioned in a recent pamphlet (Form 1911) and illustrated in the electrical section of the Home Office Industrial Museum (Horseferry-road, Westminster). This particular accident might well be classed as one due to inadequate lighting, for it is surely wrong that workers, in order to be able to see what they are doing, should have to transfer pendant electric lamps from one part of the workshop to another.

Illuminating Engineering in Australia

As we go to press we receive a copy of the Annual Report of the Illuminating Engineering Society of Australia, which has recently become an incorporated body. Amalgamation, under the existing registered Constitution, of the bodies existing in two States of the Commonwealth is now being considered. The past year has been a successful one, and a useful increase in the total membership (now 119) is recorded. During the session eight papers on such subjects as Photometry, Gas Discharge Tube Lighting, Architectural Lighting, and Electromatic Traffic Control were read. A successful innovation (on similar lines to the plan followed at opening meetings in this country) was the organisation of a display of lighting equipment.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Illuminating Engineering Society

Notes on Recent Meetings & Events

Meeting in London, December 11.

A MEETING of the Illuminating Engineering Society took place in the Lecture Theatre of the Institution of Mechanical Engineers (Storey's Gate, Westminster, S.W.1) on Tuesday, December 11. Members assembled for light refreshments at 6.30 p.m., and the chair was taken by the President (Mr. H. Hepworth Thompson) at 7 p.m.

The Minutes of the last Meeting having been taken as read, the Hon. Secretary read out the names of applicants for membership, which is appended. The names of those presented at the last meeting on November 13* were read again, and these gentlemen were formally declared members of the Society.

The President then called upon Mr. H. E. Bloor to present his paper on "Floodlighting By Gas," which was illustrated by numerous attractive lantern slides, and also by illuminated positives of floodlighting installations throughout the country illuminated from behind by tinted light.

In the subsequent discussion Mr. R. J. Rogers (Birmingham), Mr. Percy Good, Mr. J. C. Clark, Mr. C. A. Masterman, Mr. A. M. Bell, Mr. J. R. Hepple (Newcastle), Mr. F. C. Smith, Mr. A. Cunnington, Mr. A. G. Brown, and Mr. J. H. Burman took part. After Mr. Bloor had replied to comments, a cordial vote of thanks to him for his paper terminated the proceedings.

* Illuminating Engineer, December, 1934, p. 388.

(Mr. Bloor's paper and the ensuing discussion will appear in our next issue.)

Forthcoming Events.

January 8. Mr. L. G. APPLEBEE on **The Cavalcade of Stage Lighting;** *(General Meeting, Illuminating Engineering Society, to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1);* **6.30 p.m.**

January 15, Visit *of Members of the Illuminating Engineering Society to the* **New Home of the Royal Institute of British Architects** *(66, Portland Place, London, W.);* **5.30 p.m.**

February 5. Annual Dinner *of the Illuminating Engineering Society, at the Trocadero Restaurant, Piccadilly, W.;* **7 for 7.30 p.m.**

Applicants for Membership.

CORPORATE MEMBERS:—

Ashby, O. ..... The East Kent Gas Co., 22, High Street, Whitstable, KENT.

Davidson, C. S. ... Electricity Works, High Street, Mortlake, LONDON, S.W.14.

Gunton, Maj. H.C. Rathgar, Gerrards Cross, BUCKS.

Porter, E. C. R. ... Metropolitan-Vickers Electrical Co., Ltd., Bush House, Aldwych, LONDON, W.C.2.

Tolton, W. G..... 5, Southdown Road, Wimbledon, LONDON, S.W.20.

Wales, W. A. ..... 33, Chandos House, Buckingham Gate, LONDON, S.W.1.

Vereker, H. C. ... Ionlite, Ltd., 89, Scrubs Lane, LONDON, N.W.10.

COUNTRY MEMBERS:—

Astbury, E. ..... The Liverpool Gas Co., Duke Street, LIVERPOOL.

Bill, H. E. ..... Crown Engineering Works, Waterloo Street, Tipton, STAFFS.

AFFILIATED STUDENT:—

Kaplan, E. ..... 87, Wargrave Avenue, LONDON, N.15.

The Outstanding Characteristics of Illumination by Electricity

Address delivered By Mr. C. W. Sully (Past President of the Illuminating Engineering Society) before the Electrical Association for Women on December 3, 1934

THOSE members of the Illuminating Engineering Society who attended, by invitation, the meeting of the E.A.W. on December 3, were rewarded by a pleasant evening. Mr. Sully's address proved to be just what the occasion demanded. It was illustrated by a number of effective demonstrations, such as displays of the latest forms of tubular "architectural lighting" lamps, and a curtain, impregnated with the fluorescing materials, which revealed attractive colouring under the ultra-violet radiation of an incandescent dark bulb lamp.

In his opening remarks Mr. Sully emphasised the importance of *control* in the lighting of the home. Natural lighting is, in fact, very far from being under control. Even on a dull day its intensity may vary from 10 to 100 foot-candles within a short period and the variation in conditions, as between a dull day and full sunlight, is very considerable. Artificial lighting should aim at imitating the good effects of daylight. In particular we should seek to control (1) The *Distribution*, by ensuring absence of glare; (2) The *Quantity*, by supplying sufficient light; and (3) The *Quality* by providing a satisfactory colour. The adaptability of electric lighting, in enabling this to be done, is one of its chief assets.

Glare in Distribution.

All modern sources of light tend to produce glare when uncontrolled. The gas-filled lamp is much more economical than its predecessors, but the visible filament is much reduced and the brightness is therefore greatly increased. In the new "coiled coil" lamp the visible area of light is still further diminished and the brightness accentuated. The inside frosted ("Pearl") and opal bulbs furnish means of diminishing this brightness which, however, still remains greater than that of windows admitting daylight. Hence modern lighting aims at concealing the source of light, the bulb, by the use of glass, frosted, obscured or coloured, which may be in any suitable shape. The larger the surface of the enclosing glass, the lesser the glare becomes.

Sufficiency of Light.

Our forbears depended almost entirely upon daylight, the very intensity of which encouraged the use of dark decorations (panelling, heavily patterned wallpapers and carpets, furniture in dark wood). In the days of expensive electricity it was natural to furnish light only where and when it was needed—hence the use of wall brackets, table and floor standards, etc. But in the present century habits have changed, people move about after dark much more than heretofore. Night restaurants and entertainments have become familiar. As much as half our wakeful hours may now be spent under artificial light. Can we, therefore, remain satisfied with so much less light in the evening as compared with day?

All this is appreciated by the modern architect who is taking much more interest in artificial lighting than in the past, and adopting methods based on the use of larger luminous areas. With electricity at a penny a unit or less, more light may be used. The old habit of obtaining light from a single point should be discarded and the sources distributed throughout the room. The use of table standards should not be despised—but they should be applied to produce extra lighting on one's book or work, up to 50 foot-candles or more, rather than serve as the only means of illumination. Fashions are communal, so that the fashion of "more light" should in time become universal.

In concluding this section of his address Mr. Sully urged the E.A.W. to set up a Committee of its members in order to study the illumination necessary in various parts of the home in the interests of good vision.

Quality: The Provision of Satisfactory Colour.

The advance in the efficiency of lamps has been accompanied by a change in colour, the light yielded by the latest types being less yellow than that of the older lamps. The colour may, however, be changed by spraying the bulb with suitable pigments, or by the use of tinted glass. The lighting of the ballroom with yellow-sprayed lamps at an I.M.E.A. Convention some years ago did not find favour with the ladies. The effects produced by the monochromatic light furnished by some forms of electric discharge lamps are, however, much more startling. The use of Neon tubing for advertising has in the meantime encouraged the study of the use of light for decoration. In the home the use of relatively large illuminated and coloured surfaces as decorative objects rather than for purposes of illumination is being explored—a field of special interest at this season of the year. Effective use may thus be made of "blocks of light," or the source may be completely concealed and applied to illuminate curtains, etc. New forms of tubular lamps furnish lines of light in various colours.

Lighting, moreover, is closely associated with furnishing. The fashion for modern painted furniture has perhaps been encouraged by lack of sufficient light. With more abundant illumination the darker colour and attractive grain of the natural wood might be found preferable. The possibilities of incorporating the source of light in the furniture itself is only now beginning to receive attention. Mr. Sully showed a pleasing picture of an armchair thus equipped with a lamp at a convenient height for reading. The building of bedsteads with mirrors, bookcases, cupboards, etc., with lamps incorporated in them at convenient positions is doubtless quite feasible.

Conclusion.

In conclusion Mr. Sully remarked that general lighting is so important for many secondary spheres of "seeing" that even *alone* it is usually better than localised lighting *alone*. The advantages, however, of a combination of general lighting and localised lighting, properly controlled, are evident. Such lighting furnishes an easy and inexpensive way of getting really high intensities of illumination and makes possible a flexibility not otherwise obtainable. Further it enables light of any special quality, such as would aid vision better than an ordinary light, to be applied at any desired place. The adaptability of electricity renders it easy to change the positions of points, so that the appearance and atmosphere of rooms can thus be readily changed from time to time. It is strange to find in some homes lighting fixtures which remain precisely the same, decade after decade, although the decorations and general arrangements in the rooms are brought up to date, almost after every spring-cleaning! The lighting of the home today is handicapped by the absence of artistic incentive in those on whom we lean to provide the means of illumination. Many contractors do not realise the importance of such matters as distribution, quantity and quality of light and do not encourage minor alterations and additions necessary from time to time in order to bring the original installations up to date. They would be more successful in doing so, the lecturer pointed out, if they sought the assistance of those from whom the W.E.A. drew its members—those who are responsible for the real atmosphere of the home.

Industrial Lighting: Some Problems in Sheffield and their Solution

By R. W. DANIEL, B.Sc., A.M.Inst.C.E.
(H.M. Inspector of Factories).

Paper read at the meeting of the Illuminating Engineering Society, held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 6.30 p.m., on Tuesday, November 13, 1934

WITH a long and interesting industrial history, Sheffield is, to-day, the largest steel-producing centre in the country, and manufactures most of our national output of silverware, cutlery, and edge tools. It has a population of over half a million and contains about three thousand registered factories in which power machinery is used, and about a thousand workshops in which it is not. The great majority of these workplaces were erected before the beginning of the present century, at a time when the provision of adequate lighting, both natural and artificial, received but little attention. Custom and tradition die slowly in long-established industries; a few months ago Mr. Bernard Shaw said something to this effect: "Most of the maladjustments of modern life are the result of time lag in history. Things have changed, but People are not sensible of that change for whole decades afterwards; as a consequence, old methods, modes, and so forth persist beyond the conditions for which they were formulated." And so, although structural and atmospheric conditions were such as to make good lighting highly desirable, ignorance and apathy held their sway, and the effects of poor illumination on human effort and well-being long passed unnoticed.

Public interest in artificial illumination is, however, recorded as early as 1734, when, at a meeting held at a "Mrs. Horsfields," it was resolved that certain street lamps be provided. On grounds of economy, it was further decided that the lamps should remain unlit when, by the calendar, there was a moon, and, in celebration of these momentous decisions, the sum of four shillings and sixpence was voted for the provision of suitable refreshment.

General interest in industrial lighting is of later origin. In 1931, visits by the International Illuminating Congress to certain Sheffield factories drew attention to the standards of illumination encountered there, and in consequence an inquiry was made by the Factory Department of the Home Office as to the conditions prevailing. Approximately five hundred factories were visited, and three thousand photometric readings taken. (The variety of conditions in regard to intensity of illumination is illustrated in the "Frequency of Occurrence" Curves (Figs. 1—5).) On the observations made these comments are based. It is proposed to consider the basic industries of the city under seven general headings, outlining the lighting conditions prevailing under each. The problems indicated and their possible solution will conclude the paper.

Cutlery.

The manufacture of Sheffield cutlery is of very ancient origin. The Romans operated ironworks at Kimberworth, grinding and forging their tools by the aid of Sheffield's five converging rivers. Between 1600 and 1624 the Cutlers Company was formed, and in 1669 Cardinal Richelieu, with a view to reducing assassinations at table, introduced the rounded-end table knife, whereby the trade prospered greatly.

To-day the Sheffield cutlery factories vary enormously in size and condition. Many comprise only a small room, to which almost a century has brought little change; a few house daily several hundred persons. Very few are of modern construction. The majority of the smaller factories do not to-day produce a completed article, but specialise in one or more of the processes involved. Knife forgings and spoon and fork blanks, made in one factory, are sold to another, from which they are immediately issued to numerous grinders, cutlers, and buffing "teams." After thus taking shape in a multiplicity of small workrooms, they eventually return to the issuing factory for final polishing and packing. Only in the fewer large factories are these processes completed under the one roof.

These larger factories are usually lit with reasonable adequacy, but glare is ever present, and failure to employ, correctly, modern sources of light may often appear an even greater evil than much of the less serious inadequacy of obsolete systems.

Thus, in one instance, five workbench places in a room of about four hundred and twenty-five square feet were illuminated by fifteen totally unscreened 150-watt clear lamps. The lighting was later immeasurably improved by the efficient use of only 22 per cent. of this original consumption. Yet in a large adjacent grinding hull less than 1 foot-candle was available for much finer work!

A far greater problem is presented by the numerous smaller factories, in which hundreds of persons work in twos and threes and tens and dozens, under the direction of team foremen or "little masters." Most of their workrooms are registered tenement factories, the remainder, similar in condition and appearance, differ mainly on a technical point, relating to the origin of the mechanical power used. By legal definition a tenement factory is one in which mechanical power is supplied to different parts of the same building, occupied by different persons for the purpose of any manufacturing process or handicraft, in such a manner that those parts constitute in law separate factories.

The buildings are mostly old structures of three or four storeys peculiarly divided and subdivided into numerous separate workrooms. In each of these one or more person or persons may rent grinding troughs or sets of stocks, each driven by belts and countershafting from a central prime mover. Each person becomes, legally, a tenement occupier and may, or may not, employ other persons. In this manner two hundred or more persons, mostly employed in cutlery and silverware processes, may be housed in each building. Obsolete architectural design, small windows, adherent dirt and proximity to other buildings, inevitably lead to naturally dark interiors.

Crude artificial lighting is provided and is used as such. Lighting charges are usually fixed at between 6d. and 9d. per point per week. The majority of gas-points are still batswing burners or open-ended pipe-flares; the landlord provides the burner, which the tenant often prefers to remove. In those electrically lit inefficient carbon or metal filament lamps are often found. Without reflectors and at improper heights they may result in even lower working intensities than those derived from neighbouring gas flares. Well-lit tenement workshops do exist, but infrequently. Some indication of the position in Tenement Factories is given in Table

Table I.

LIGHTING OF TENEMENT FACTORIES.

Type of Lighting.	Intensities (f.c.) Min.	(Mean)	Max.	Glare Severity.
Ga Flare Lit:	0.1	(0.6)	1.25	—
	0.5	(0.8)	1.2	—
	0.125	(0.29)	0.5	—
	0.3	(0.5)	0.7	—
AVERAGE	0.25	(0.55)	0.9	
Incandescent Gas Lit:	0.3	(2.6)	6	(0)— 75—25—0
	2.0	(2.25)	3	(0)— 75—25—0
	1.75	(2.5)	3.25	(0)—100— 0—0
AVERAGE	1.0	(2.4)	6.1	(0)— 83—17—0
Electrically Lit:	1.25	(3.8)	7.0	(0)— 75—25—0
	0.5	(2.25)	5.5	(25)— 50—25—0
	2.0	(2.5)	3.0	(0)— 75—25—0

Table II.

Types of Lighting in Cutlery Factories.	No. of Factories.	Intensities (foot-candles).
Electrically lit:		
Local points in shallow conical reflectors with some glare	11	2 —8
No screening whatsoever:		
40-100w. pearl bulbs with bad glare	5	1½—2½
60-100w. clear bulbs with very bad glare	3	2 —5
Absence of local glare due to elevated positioning	2	2½—5
Effectively screened by suitable local reflectors	3	6 —16
Gas lit:		
Absence of local glare due to elevated positioning	3	2½—5
No screening with bad local glare ...	2	2 —7

I, whilst Table II. deals with the intensity of illumination prevalent in Cutlery Factories, generally.

The Factory and Workshops Acts definitely distribute between the tenement owner and the occupiers various legal requirements. But lighting is not amongst them, and thus remains too often in its crudest form. Men can look back over sixty years and see little change. Complaint is common, but improvement is slow to follow. The tenement owner has little to gain from it monetarily, whilst the tenants give no thought to improvements on premises insecurely held on weekly tenancies. Few tenants, moreover, have the knowledge and foresight to reduce such long-standing inefficiencies. Lack of co-operation produces the strange anomaly that in the case of gas-lit tenements the use of flares in place of incandescent mantles simultaneously reduces the tenant's output and quadruples the overhead gas consumption charges payable by the landlord.

Silverware and Electro Plate.

Factory conditions in the cutlery and silverware trades are somewhat allied, in that many factories simultaneously manufacture both commodities. But the silversmith's trade has, in the main, the advantage of being confined to larger buildings, in which some form of maintenance is usually recognised. With few exceptions, however, these buildings are old and comprise numerous separate workrooms on two, three, or more floors. Whilst such conditions necessarily limit the efficiency of any system of lighting, they cannot explain the extremely poor illumination frequently encountered. Even a little attention would effect considerable improvement.

Less than 8 per cent. of the factories visited were efficiently lit. Elsewhere, while the lighting was generally adequate, it was badly disposed, and glare was common, often severe. Tissue paper is widely used on local points by individual craftsmen, but no methodical application of this diffusing principle was discovered Again, actual working intensities, for identical processes, even in the same factory, often vary widely. Examples show from 2 to 15 foot-candles for buffing processes in the same room, from 3½ to 25 foot-candles for hand shaping of hollow-ware, and from 4 to 12 foot-candles for inspecting and polishing and wrapping. Glare was noticeable in each case.

The intricate nature of many processes, and the ever present reflection from the polished surfaces, present numerous illumination problems, which have in the past received little attention. Judicious use of diffused corrected artificial light should do much in the future towards their solution.

Following the enquiry, several firms have, however, undoubtedly effected considerable improvement. In several instances, admirable modern reflectors have been spun from Britannia metal, and diffusing units have been effectively introduced. But trained scientific aid is needed generally to eliminate the loss that faulty lighting annually extracts from this industry.

Steel Tools.

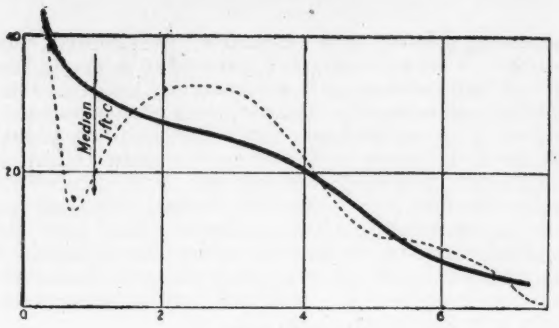
In addition to the usual implements required by surgeons, dentists, barbers, mechanics, and carpenters, many unusual tools, machetes, corkscrews, power-driven sheep shears, etc., are produced under the general heading of "edge tools." Lighting conditions are usually a little better than those encountered in the cutlery trades; but the fineness of the work involved, which varies greatly, too often bears but little relation to the standard of illumination provided. Thus, whilst in one factory good high-pressure gas lighting provided 6 foot-candles for the relatively "coarse" work of machine-grinding circular saws, 2½ foot-candles only was available in another for hand-filing and setting the saw teeth. Average conditions are thus often difficult to determine.

Scythes, sickles, and similar tools are still largely hand-ground. The grinder sits before, and works almost on top of, the wheel. A series of minute or half-minute spells of grinding or buffing produce the finished edge and surface. Between each spell the progress of the cut has to be examined, whilst a careful watch must be kept for any discolouration denoting loss of temper. Good artificial lighting is essential, but in actual practice it is often poor. In the worst cases, notably the tenement factories, hours of darkness may introduce a "hit and miss" form of progress, necessitating reinspection, and, where faulty, regrinding next day. Intensities were found to vary from 14 foot-candle in the best instance to under a ½ foot-candle in the worst. In one case, the misuse of adequate daylight bulbs provided but 1 foot-candle on the working plane, in another intensities in adjacent hulls varied from as much as 2 to 12.

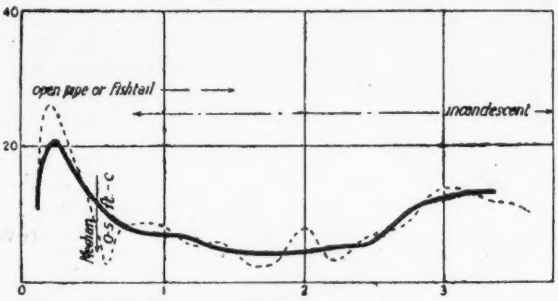
In the majority of cases the fault lies in the absence of proper reflectors on the points provided. Spray and "swarf" flying from the wheels make general lighting preferable on grounds of maintenance and cleanliness. Without reflectors, or where they are shallow and dirty, and hence of trifling value, glare and inadequacy are inevitable.

In the manufacture of files, high-speed machines have almost entirely superseded the old hand-cutting methods. Local lighting is usually adequate but often severely glaring. Incandescent mantles and 100-watt clear bulbs (totally unscreened) within a few inches of the cutting edge were often seen. Several firms have now adopted adequately screened miniature lighting, at 12 volts 18 watts, for these machines, with considerable success. The added initial cost of these low voltage installations, about 33⅓ per cent., is soon repaid by the decreased consumption and the longer lives of the more robust miniature filaments. In one factory, points for 300 machines are well in hand. This system is worthy of greater industrial application generally.

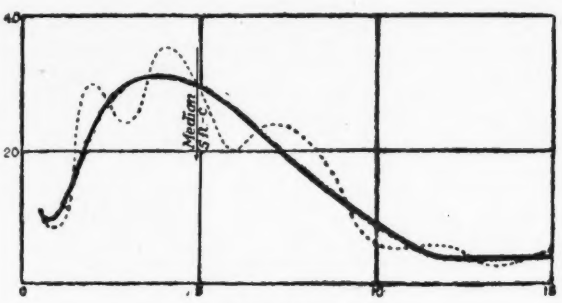
The manufacture of twist drills approximates to that of files, from a lighting standpoint. Low voltage



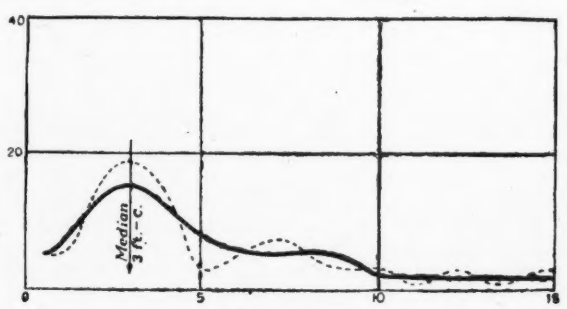
Foot-candles.
Fig 1 Tenement factories all classes.



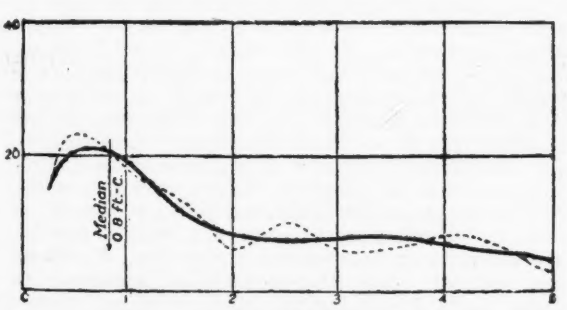
Foot-candles.
Fig 2 Tenement factories . gas-lit only



Foot-candles.
Fig. 3. Cutlery and silversmiths buffing.



Foot-candles.
Fig. 4. Cutlery grinding , employers' hulls.



Foot-candles.
Fig. 5 Foundries

Frequency of Occurrence Curves

Fig. 6. An inspection bench in a small warehouse, lit by bare bulb electric lamps in shallow conical reflectors. Similarly constructed points are often found actually at eye level.

Fig. 7. A section of a workshop devoted to cutlery "buffing" (polishing), where flat flame gas burners on jointed-piping form the sole illuminant. A pile of spoons may be seen on the bench.

Fig. 8. Another workshop where a more modern form of gas lighting, with incandescent mantles, has been substituted, though the mantle is still unshielded.

Some Examples of Industrial Lighting in the Sheffield Area

points have again met with success for several processes, including "backing off," performed by hand at miniature abrasive wheels.

Micrometers, gauges, and similar engineers' tools necessitate very accurate workmanship; even automatic workroom temperature control is considered necessary in some factories. In these, good adequate lighting is usual, although in some haphazard and glaring conditions still prevail.

The manufacture of safety razor blades is now a large and prosperous industry, employing mainly female labour. The processes are largely automatic, but the inspection of the blade edges is an extremely fine visual process. Batches of about fifty blades are so handled that the blade edges are rapidly, yet closely, observed separately on each face and collectively in plan. Faults invisible to the untrained are thus not only detected but simultaneously graded for repassing through various processes. Large firms employ from two to twenty inspectors, according to the quality of the blade, and each inspector may handle from five to twenty thousand blades in an eight-hour day.

Inspection may be performed on an open table, but most of the firms producing superior grade blades utilise small wooden cabinets of approximately three feet cube. These are mounted on black baize-covered benches and finished matte black internally. The blades are examined under a strong local light. High intensities are essential for the inspection of the bunched blade edges, where faults appear as faint grey specks or streaks as on a small background of black velvet. (See Fig. 9.)

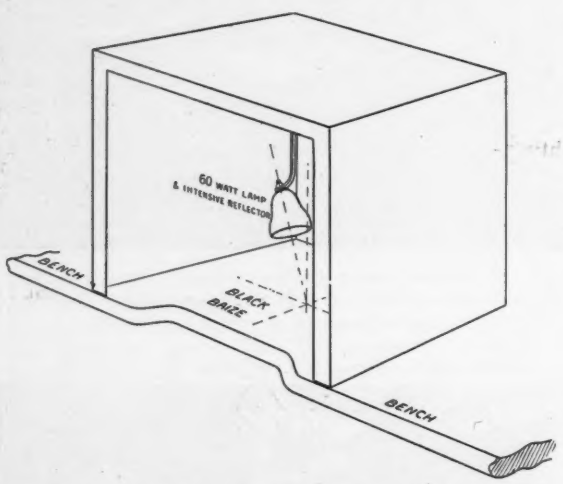


Fig 9. Device to facilitate inspection of safety razor blades.

Various experiments have been made in the lighting of this process. Carefully placed 60-watt daylight bulbs in suitable reflectors and mercury vapour lamps have both proved very satisfactory. The soft but intense light of the latter is particularly appreciated, but lamps at present available are rather large and clumsy for local use. It is suggested that smaller units will, when produced, prove of great value for this and for several other inspection processes. The psychologically depressing effect often produced can be largely eliminated by carefully confining the light to the area under observation.

Steelworks.

The general lighting observed in Sheffield steelworks is of a higher standard than that encountered in other local industries, and general working intensities sometimes exceed those provided for much finer work elsewhere. Local lighting, where provided, is, however, frequently poor and glaring. Adequate maintenance is also much neglected, largely, it would appear, on account of the height and inaccessibility of the general units employed; increasing loss then becomes inevitable. One example, a rolling mill, is of particular interest. Two sets of rod and bar rolls are centrally driven. Both sets are structurally similar, and both sets were originally lit by the same number of similarly placed old 300-watt lamps in discoloured shallow reflectors. The mean working intensity on both floors was 4½ foot-candles. By replacing similarly situated test points, comprising 150-watt lamps, one half the original capacity, in modern reflectors experimentally over one side, the average reading was increased to 6 foot-candles. The mill with two other associate mills was thereupon re-lit.

With the general trade recovery certain other mills are rapidly completing modern installations of a high standard. In one, the mill floor is lit to an intensity of 8 foot-candles by large new gaseous discharge units, controlled through relays by photo-electric cells. By a dual circuit, twilight and darkness automatically switches on the lighting in two stages. In another instance, a large rolling mill has been relit by improved high-pressure gas units, with excellent results. Many smaller mills and forges have, however, been slow to follow the lead of their larger neighbours. Steel forging is still largely an ill-lit industry, 0.3 foot-candles, and even less, being not uncommon. Maintenance is much neglected, and in one instance photometric readings showed that accumulated dust had reduced the intensity derived from a modern installation by 66 per cent. throughout.

Rolling mills call for good general lighting, and in view of the erratic behaviour of the flicking tails of red-hot bar and wire, complete elimination of glare is very necessary. Sufficient illumination must also be provided at the rolls for easy reading of the micrometer gauges constantly in use.

Billet grinding, with a subsequent careful examination of the ground surfaces for cracks and flaws, also calls for, but often fails to receive, adequate and carefully placed local lighting. Both inadequacy and glare, the latter either direct or reflected from the polished surfaces, are thus still common.

The close examination of polished stainless steel and of nickel silver sheets is a further process necessitating careful lighting. Images mirrored in the surfaces undergoing inspection may otherwise cause severe eyestrain. Diffused lighting is an obvious solution, and Mr. J. M. Waldram, of the G.E.C. Research Laboratories, has suggested the addition of dark longitudinal bands to the diffusing unit.

Among the steelworks a light-operated safety signal device, recently instituted, is of particular interest. A busy length of permanent way, passing several workroom doorways, was floodlit from the out-running end. At the other, a photo-electric cell was coupled to a relay. Intrusion of a locomotive, or other vehicle, into the light beam, thus caused red danger signals to glow in all doorways opening to the track.

Foundries.

The tradition that hot metal needs no light dies hard, and both forges and foundries still adhere largely to this belief. The value of good lighting in the taking of accurate measurements, and in the careful moulding among dark sand, is overlooked. Most Sheffield foundries are but dimly lit. Of those in which photometric readings were taken only 10 per cent. showed mean working intensities in excess of 5 foot-candles. Twenty-three per cent. showed less than ½ foot-candle, and 71 per cent. less than 2. Under such conditions small moulding irregularities are most difficult to detect. Yet in only five foundries was the lighting consumption estimated to be insufficient to have provided adequate illumination if correctly used. Further, in seven cases the reasonably adequate lighting provided was practically halved in value by accumulated grime. A quick dusting of the best unit found in this indus-

try gave an instantaneous rise in floor intensity beneath it of from 7 to 12 foot-candles.

In the smaller ill-lit foundries low, totally unscreened, points are often encountered. Against the dark background the glare is severe, and with molten metal in frequent use may increase working hazards.

"Fettling," the cleaning of the castings, is usually carried on at abrasive wheels in an adjacent shop. Lighting is often extremely poor, alleviating but little the natural dinginess and darkness of so many of these rooms. In comparison a few foundries recently re-lit show a striking contrast.

Engineering.

Many heavy engineering shops are less well lit than might be expected. General lighting, inadequately maintained and developed, makes accurate observation difficult, and carbon filament handlamps are frequently resorted to. Such lighting is unsatisfactory, and one large firm is introducing portable floodlighting stand lamps.

Among lighter engineering works there is a tendency to revert to exclusively general lighting, eliminating all local points. Even with a powerful installation of this kind there is frequent complaint of local inadequacy, and low-voltage lighting is again suggested as a solution.

In concluding, we have to consider possible solutions of the problems, numerous and complex, that have been presented. It is very apparent that the primary obstacle is of human and not of technical origin. Not until it is locally recognised that illumination is both an art and a science will any real progress be made. The absolute necessity for suitable artificial lighting once accepted by the factory owner, the lighting engineer is left with a relatively easy task. In nearly every instance he can both improve the lighting and decrease the cost.

Lack of standards of comparison, a condition of universally bad lighting, creates the first and major problem in this necessary educational process. The well-meaning author of the old adage, "Good wine needs no bush,'" has been responsible for many bankruptcies. It is the writer's experience that few factory occupiers attempt to improve the factory lighting, however bad, until favourable conditions seen elsewhere destroy faith in their own. A few well-lit workshops, accessible to competitive manufacturers, thus achieve much; by compelling unfavourable comparison they create dissatisfaction—an essential prelude to improved conditions.

At one visit to a file factory, employing about forty men, three elderly craftsmen were found cutting special small files by hand. Before each, clipped in an ancient bracket, was a candle. No other illumination was available. The senior cutter, in his sixty-fifth year, had spent almost forty years of his life in the same shop, during which time he had known no other form of artificial illumination. It was, he agreed, a poor light by modern standards, and he felt the strain that it imposed. His wife usually read the paper to him in the evening for that reason. He supposed his employers would have installed a modern light if he had asked them, but he had never elected to do so. The firm, in their turn, mentioned that they would be sorry to lose him; good hand cutters were very scarce nowadays. Their gas main actually passed the shop doorway, but somehow the question of carrying it in had never been raised. They would certainly install points if recommended to do so. Within a month incandescent points appeared, but in spite of careful instruction they were so placed that glare materially spoiled the benefit of the extra light. Ironically enough, frosted glass windows, directly across the road, obscured good modern factory lighting from their view.

Such circumstances are admittedly exceptional, but that they should remain to-day without undue comment, either among masters or men, is a disturbing fact. Even among the most progressive factories the recent depression had been permitted to restrict improvements long overdue. Indeed, false economy, an insufficient realisation of the true balance between profit and progress, may render poor lighting worse. In a few instances the wattage of lighting points throughout a few factories was, during the recent depression, systematically reduced, in cases halved. The ingenuous admission of the manager of one of the larger silverware manufacturers that the factory lighting had not been materially altered since its installation, twenty years previously, but that no improvements could be contemplated without a considerable trade revival, is not without an element of grim humour.

Even amongst new or reconstructed factories this same false economy has led to several seriously inefficient installations. Lighting contracts are still at times placed on price per point alone. Types of fittings, standards, and suitability of illumination are not then considered. In two conspicuous examples, large, newly built factories were provided throughout with haphazard points, both local and general, in the cheaper, shallow conical reflectors. In the major case, six hundred 60 and 100-watt local points so equipped proved extremely glaring and wasteful. Yet had the installation been scientifically designed in the first instance, increased efficiency and decreased consumption must have repaid the higher initial cost in quite a short period.

In this respect it must be admitted that the heavy cost of reflectors, particularly local reflectors, had until recently undoubtedly hindered progress. Some firms, declining to pay prices asked, produced their own by spinning or stamping suitable sheet metal. Of late, however, several suitable types at greatly reduced prices have been marketed, and a considerable number put into use in consequence. Recent reduction also in the cost of electricity for industrial lighting has done much to extend its use. In several other factories, again, conspicuously improved incandescent gas lighting has recently appeared.

The need for improved lighting having been appreciated, and its provision agreed upon, two major problems remain. To ensure that the installation is well designed in the first place, and, further, that it

Table III.

COMPARATIVE GLARE SEVERITY TABLE.

Industry—Process.	Free from glare %	Per cent. Glare severity. G_1	G_2	G_3
SILVERSMITH:				
Industry as a whole	10	43	34	13
Bench work	27	39	23	11
Buffing	16	60	16	8
Electroplating	10	70	20	—
CUTLERY*:				
Sheet rolling	23	70	5	—
Blanking out and drop-stamping	25	60	15	—
Grinding: Electric-lighting	33	50	17	—
Incandescent gas	—	50	25	25
Buffing	15	28	38	19
Packing and polishing	40	40	20	—
STEEL TOOLS:				
*Saw grinding	14	36	24	24
Joiners' tools	23	57	12	8
*Do. omitting grinding	10	30	50	10
Engineers' tools, gauges, etc.	36	48	12	4
*STEEL FORGING AND ROLLING	27	60	13	—
FOUNDRIES	35	40	20	5
*HEAVY ENGINEERING	30	50	10	10

* Estimated from limited observations only.

NOTE—

G_1 Some glare; from lower power local pearl bulbs partly screened, light background, and similar.

G_2 Bad glare; from higher power bulbs unscreened, and/or closer range, medium background, and similar.

G_3 Very bad glare; clear or G.F. bulbs unscreened, close range, dark background.

is subsequently properly maintained. In any efficiently planned lighting installation, glare is to-day carefully eliminated, but where lighting is provided, and points added and shifted piecemeal, this desired effect is often not obtained. In the majority of factories visited, glare was prevalent, six only being entirely free from it, and in an attempt to obtain systematic comparisons a table presenting glare severity figures was prepared. (Table III.)

Completely unscreened electric lamps or incandescent gas mantles were responsible for the more severe cases, as might be expected, but the great majority arose from the continued use of the old shallow 10-inch conical reflector. Only eight of the factories visited had wholly dispensed with these. Elsewhere they were still largely used. Photometric observations show that to obtain from such a shallow reflector the same working intensity as that normally derived from a correctly designed model, a lamp of approximately double the wattage is necessary. If, now, the prevalence of gas flares and of obsolete lamps is also borne in mind, the absurd conclusion is reached that possibly more light is wasted in some factories than is required to alleviate the dimness encountered in the others.

Maintenance.

Of the factories visited only five provided for efficient lighting maintenance. In several instances measurements of illumination taken under even expensive modern fittings were doubled or trebled after the accumulated grime had been removed. Regular cleaning is most commonly neglected where units are somewhat inaccessible or are of a type in which dirt can remain hidden. Apathy in the matter is often as complete in those factories containing expensive modern fittings as in those in which older and cruder lighting still remains. In a large press shop, six out of eleven expensive adjustable bracket local points were without both the bulbs and the reflectors originally provided. Glaring portable hand lamps, unsuitably placed, had been substituted by the operatives. Yet a trifling attention could have provided local lighting of a high standard.

As for the future, there is room for optimism, despite the gloominess of much of this recent survey. The tide has turned, trade is increasing. Confidence is returning, and during the latter part of the enquiry a desire for improvement became increasingly apparent. Defects, long ignored because of "bad times," begin to receive attention, and, with a little encouragement, lighting has its share. During the past year over a hundred factories have carried out or are projecting improvements; others will follow. Many at present are of a minor character only, but they introduce the essential note of comparison that must inevitably lead to wider application.

In this connection the following paragraph relating to conditions in the Sheffield area, which appeared in the Chief Inspector's annual report for 1933, may fitly be quoted:—

"The above enquiry, for instance, in which the City Council showed great interest, has led to some remarkable results in the direction of improved lighting. Out of 475 factories visited, only 27 were found already to possess really up-to-date installations. In the remainder the recommendations made, following various tests and demonstrations by a direct reading photometer, have led to improved conditions, wholly or partly completed, in 128 factories, and in seventeen more similar progress is anticipated."

Eventually good lighting must surely be accepted universally as an essential feature of a progressive factory; a source of continuing profit no less to master than to man

EXPLANATORY NOTE.

In the Frequency of Occurrence Curves (see p. 7) the Abcissae show working intensities for the process, in foot candles. The ordinate, at any particular foot candle (abcissae) value, is proportionate to the total number of photometric readings taken having that particular value.

DISCUSSION.

The CHAIRMAN remarked that although the author had drawn a somewhat gloomy picture of the lighting conditions in some of the industries in Sheffield there was really a pleasing side, because it all meant there was a tremendous field for new business. Although it might be sad to them as idealists to know that such conditions existed at the present time, it was most desirable that those described in the paper should be brought to notice. The problem in Sheffield, however, was a special one by reason of the operating conditions which had been described. Interest in, and responsibility for, good lighting conditions was greatly subdivided by the work being carried out by so many small master workers. The position was quite different when dealing with a large factory. Perhaps some light would be thrown upon that question in the discussion. Hitherto the aim of those interested in improving lighting conditions was to tackle the employer, but was there any reason why an effort should not be made to interest the workmen's unions? These bodies put a great deal of effort into the problem of improving wages and working conditions generally. Was it not time that they should also give their attention to the lighting problem? It was a satisfaction to know that Government officials concerned with factory administration were willing to help to straighten out this problem Their desire to do so was amply illustrated by the paper.

Major H. C. GUNTON congratulated the author on the value of his paper, which, although it presented necessarily a gloomy picture, held out some hope of improvement in the near future. He said he had been associated for about twenty-five years with the supply of illumination to the staff of one of the largest Government departments, the employees numbering about 250,000 in various parts of the country, viz., the Post Office, and a great deal of satisfaction had been afforded to these workers by a small body of engineers supported by a powerful committee from outside the Post Office, viz., a committee which had dealt with the Lighting of Public Buildings. In that way standards of illumination had been arrived at and the information so collected had been distributed in such a manner that the staff in various parts of the country were made aware of the latest developments in illumination. Undoubtedly, the key to the problem, mentioned by the Chairman, was the getting at the people concerned in the most effective manner, because there was a vast amount of information now available, thanks to the work carried out by such organisations as the National Physical Laboratory, E.L.M.A., the National Illumination Commission of Great Britain and its subcommittees, and by this Society. The difficulty was to get that information through to the people whose lighting conditions obviously should be improved. Publicity, of course, was the order of the day, but it would have to be handled very carefully in such a matter as this, and the suggestion by the Chairman that steps should be taken to interest the trade unions was an exceedingly valuable one; the assistance of the medical profession would also help enormously.

Mr. A. CUNNINGTON emphasised the extreme importance of paying attention to the maintenance of lighting installations. The difficulty was that factory managements, when they were induced to improve their lighting conditions, went to contractors and were inclined to accept the lowest tender, but if the contracts did not provide for adequate maintenance subsequently, then difficulties were bound to arise. Therefore, he suggested that in the education of salesmen special attention should be paid to this problem of maintenance as well as to the mere selling of light or lamps. It would be an excellent thing if salesmen who sold fittings were compelled to go back

again after a few months to see the condition of the fittings, and periodically to keep an eye on things from that point of view. It might be said that this was nothing to do with the salesman, but, personally, he felt it had a very great deal to do with him, because the whole future of illumination depended upon efficient maintenance of installations. In the same way the most up-to-date advice should be made available, for on looking at some of the illustrations to the paper it was apparent that many of the fittings were unsuitable for the conditions. Obviously this maintenance involved a certain amount of expense. He knew from experience how difficult it was to get managements to see that there was another expense besides the initial expense, but that aspect had to be tackled and care taken to see that comparisons of costs of lighting installations were made on a basis of the cost of installing and maintenance, and not merely on the basis of installation costs alone. It was for this reason, he contended, there is room for educating salesmen in this matter and also getting the contractors to emphasise that side of the problem. At the same time he welcomed the efforts of the Factory Inspectors in inducing factory-owners and workers to appreciate the value of efficient lighting installations.

Mr. R. O. SUTHERLAND spoke on the architectural aspect of lighting, and remarked that about a year ago it had been suggested to him that 80 per cent. of our factories were out of date from the architectural point of view, and that, therefore, it was difficult, if not impossible, to install modern lighting arrangements. Whether that figure was on the high side or not he did not know, but a point to be borne in mind was that with the improvement of trade new factories would be built and every effort should be made to see that the lighting aspect was taken into account. Hitherto very little attention had been paid to take account of the lighting in the architectural design of factories, although there were one or two notable examples. For instance, at the Barking Power Station lighting fittings had been arranged at intervals along the girders of one of the big halls, and the effects were extraordinarily impressive as well as being thoroughly effective. Another example of this sort of thing was the Tunnel-Portland Cement Co., which had adopted a system of lighting by means of cylinders fixed to the mullions of the windows all round the laboratories, which gave the same kind of directional lighting that was obtained from daylight. On the question of maintenance—the importance of which could not be overemphasised—he asked the author whether he had any figures comparing the cost of a maintenance staff and the loss incurred due to the inefficiency of the installation when such a staff did not exist? He imagined that the comparison would be all in favour of having the maintenance staff.

Mr. A. WYLIE (Sheffield Gas Co.) pointed out that improvement in factory lighting, especially in a district which had suffered so severely during the recent slump in trade as Sheffield, was an uphill task, and the assistance of the Factory Inspectors was, therefore, the more welcome, because it was necessary. The greatest stumbling block in the Sheffield area was cost. Continuing, Mr. Wylie said that many would probably be amazed at the information given in the paper regarding the number of factories within the Sheffield area, but 90 to 95 per cent. of them consisted of one or two small apartments in a tenement building employing six to twelve people. Could it be expected that such property, obsolete in design, wanting in ventilation, and devoid of natural light, could be satisfactorily improved by the application of modern lighting? As to the use of flat flame burners and open flares, it should be borne in mind that the constant vibration in some of the processes in the Sheffield industries was such that neither an incandescent gas mantle nor an incandescent electric lamp could stand up to it. Although experiments were constantly being made to introduce a flexible incandescent gas lamp, there was still no known substitute for such fittings as a small flare or a batswing burner for use against, or in close proximity to, such machines as a steam hammer or heavy overhead gear. The Sheffield Gas Co. had a proportion of factories on their maintenance list, and it was pleasing to note that with the improvement in trade there was an indication that past endeavours to interest those responsible for factories in improved lighting had not been in vain.

Mr. J. M. WALDRAM said that, although the author might have depicted a gloomy picture, he had also thrown out a challenge, and he anticipated many people interested in lighting fittings would soon be visiting Sheffield. It was a great opportunity not only for lighting, but for lighting in the right way. He had described processes, the proper lighting of which involved a very difficult task, especially those dealing with polished metal surfaces. The examination of razor blade edges, which Mr. Daniel had described, was a very interesting process. He suggested to those interested in improving the lighting conditions that they should visit the factories and look, as it were, with the operator's eyes, and find out—what the operator generally did not know—how it was he was really seeing his work. For instance, in making a cut on a lathe, one did not look at the point of the tool, but at the edge of the cut as it went round and caught the reflection of some lighting unit or window. The same principle applied in filing something flat, the result was really judged by the little reflections of light from the surface of the work. Therefore, everything depended on the shape and brightness of the source that illuminated the work, and that was a matter which should be given careful consideration by those endeavouring to improve the lighting conditions. The author had referred to an arrangement which he himself had described a short time ago in the Journal for the examination of polished ware. This would not reveal all kinds of faults in every case; different faults required different devices. In some cases it would be necessary to use a large diffusing source; in others a concentrated beam of light from a parabolic reflector. It was necessary to study the position and the size and brightness of the sources in relation to the precise kind of detail which it was desired to reveal, and in the case of polished articles to consider the flaws themselves as optical elements, if we were to give as illuminating engineers the best possible service.

Mr. A. E. ILIFFE suggested we need a change in methods of bringing the advantages of efficient illumination to the notice of the public, and added a word of appreciation of the work being done by the Factory Inspectors in assisting in this direction. Although reference had been made to the gloomy conditions depicted in some of the author's illustrations, similar conditions were to be found in factories in the Midlands and other parts of the country, and even on the south side of London. Actually the paper did not call for discussion on the higher technique of illumination, and the outstanding point of the paper was the need for bringing to the notice of workmen and employers of the type so common in Sheffield, the need in their own interests of improving their lighting conditions. How a change of attitude on the part of some of these people was to be brought about he hardly knew at the moment,

although in some respects big strides were being made. For instance, in newer industrial areas there was a very great improvement in the type of factory lighting. It would be a very good thing if lighting and consumers' engineers in their various districts would carry out a similar survey to that which the author had carried out, and, at the same time, endeavour to induce the local trade union officials to help in assisting upon improved lighting conditions. With the progress being made in such directions as regular eye testing, medical examinations, and fatigue-reducing research, it is amazing how little attention is paid to the predominant fact that it is the eventual vision that matters, and vision is dependent upon light, natural or artificial. Industry itself must tackle this problem with the help of the lighting engineer. It was not difficult to prove that a large percentage of accidents were due to the lighting conditions. He thoroughly agreed with Mr. Cunnington that a salesman, having sold fittings or an installation, should be compelled to keep in touch with it to ensure that it was suitably maintained.

Mr. S. R. BENNETT (Superintending Inspector of Factories, Central Metropolitan Division) said he, together with a number of lady inspectors of factories, thanked the Institution for their kind hospitality. They had attended the meeting to support the author, but none of them had many criticisms to offer of the paper. Referring to some of the diagrams in the paper, however, he said they had a little difficulty, inasmuch as some explanation was not given of what the ordinates had been based upon, so that to some extent the point wished to be made was not altogether obvious. Perhaps the author would say how the tests of illumination were made, because the natural reading should be the one at the work place and as seen by the workmen. From that point of view, some of the illustrations relating to glare might be clarified a little, because, although there might be glare to visitors looking at the fitting itself, there might not necessarily be glare to the workmen at the work places.

Mr. R. O. ACKERLEY suggested that too much of the propaganda in favour of improved lighting was left to the manufacturers of lighting equipment, who were not in a position to establish direct contact with the small user. He suggested that, in order to get at such users, it was necessary for other sections of the electrical industry to take a greater interest in the matter, and particularly the supply companies in the various areas. In regard to the point that had been made concerning maintenance, the suggestion that the salesman should go back from time to time to see that an installation was being properly maintained was sound enough in itself, but was it to be expected that a man who had sold a 10s. fitting to a small factory operator was to be constantly calling at the place to see that it was in good condition? After all, salesmen could not afford to be philanthropists, and unless there was some bigger organisation to deal with maintenance, the problem of these small workers would remain a difficult one. Really, the people supplying the illuminant should take the maintenance question in hand. Without belittling the splendid work now being done by the factory inspectors, the great need was some standard regulations with regard to lighting which could be imposed upon small people at whom the ordinary propaganda did not seem to get. After all, there were standard regulations with regard to ventilation, and was it not possible to have something of the same sort as regards lighting?

Mr. J. S. PRESTON suggested that the value of good illumination design was not pressed home as often by illuminating engineers as it should be. It was almost impossible to develop any systematic relation between measured illumination values and the frequency of accidents, and the author had been wise to omit any reference to that from the paper. The real question was how the light was used. It was the system rather than the amount of light that was important.

Mr. H. H. LONG asked how the table relating to glare was arrived at, and what exactly that table really amounted to. He also asked the author if Britannia metal shades were effective in reducing glare.

Mr. J. S. Dow expressed the view that the Home Office Department should have had the power to demand adequate lighting of factories many years ago. If that had been the case, instances of absolutely shocking lighting could scarcely occur. He recalled that the Departmental (Home Office) Committee on Lighting in Factories and Workshops reported in favour of a general statutory requirement in 1915, and, previous to that—more than twenty years ago—a Departmental Committee on Accidents in Factories and Workshops had made the same recommendation. Complicated regulations were not desired—merely a general requirement of adequate lighting in simple terms, which the Home Office Factory Department could amplify or amend, in accordance with progress. He felt sure that such regulations would be sympathetically applied, and would be readily accepted as being in the interests alike of the workers and the management.

The AUTHOR, replying to the discussion, explained that the readings given on the various graphs were taken with a small photo-electric direct reading photometer. The worker leaned, for the moment, to one side, and the reading was taken at the working point, with the machinery still running. The large number of observations so made were later sorted out, and the graphs prepared from them. At any particular foot-candle reading on the abcissae, an ordinate proportionate to the total number of readings obtained of that particular value, was erected. The curves so obtained showed, as it were, the general trend of the lighting intensities prevailing for that particular trade or process. As to glare, it was unfortunate that the only slides available, were those made from existing plates showing factory interiors. None of these indicated the severe cases of glare frequently encountered. An instance was the meeting with one sixty year old worker who himself maintained a 100-watt clear gas-filled lamp 18-in. from, and 3-in. to one side of, his machine cutting tool, under constant observation.

As to the problem of expense of planning an installation being disproportionate to the results, it was not suggested that an expert was needed to visit all the small workshops illustrated, and design an installation. The improvements necessary were often of a relatively simple nature; with a little education the occupier could himself effect them. The question of cost was, however, an important, frequently a major, point. In the smaller workshops, moreover, the people were the more often reluctant to effect a change. If he might be permitted to make one criticism of the industrial North, it was of the tendency to dwell on things that had proved satisfactory in the past, to the exclusion of things that might prove better in the future.

In conclusion, the Author expressed his appreciation of the kind comments that had been made concerning the work of his department, and expressed his special thanks to the Chairman, and to Mr. Dow, for his valued assistance in connection with the paper.

On the motion of the Chairman, a cordial vote of thanks was passed to Mr. Daniel, at the conclusion of the discussion.

Industrial Lighting: Some Problems in Sheffield and their Solution

Further Discussion of Paper by Mr. R. W. Daniel in Manchester, November 28, 1934

AT a meeting held at the Engineers' Club, Manchester, on November 28, Mr. A. E. JEPSON, as Chairman of the meeting, introduced Mr. R. W. DANIEL, H.M. Inspector of Factories, Sheffield, who delivered a paper on "Industrial Lighting—Some Problems, and Their Solutions," on similar lines to that read by him in London on November 13.

Mr. J. E. JEPSON, in opening the discussion, stated that from the evidence submitted he was amazed to learn that such deplorable lighting conditions existed in these enlightened times—especially in a city reputed to have the cheapest gas and electricity in the country. He did not know of any comparable instances in the Manchester district! He also had some little experience of Sheffield, having lived in one of the suburbs at one time, and suggested that the very poor conditions under which work was carried out was due largely to the system of "little-masters" in tenement factories. It seemed incredible that the owners or landlords of the tenement factories should continue such antiquated lighting, and thus continue to pay many times more for gas and electricity than if it were efficiently used. It only required a small amount to be spent on capital cost. Mr. Jepson mentioned that 250-watt gaseous discharge lamps were being successfully used in the Manchester district for factory lighting, one advantage being that one could use a more suitable mounting height.

Mr. HIRD (H.M. Inspector of Factories, Manchester) said that if the conditions now reported were correct, it was time the people of Sheffield were educated to the value of good lighting by starting a branch of the Illuminating Engineering Society. There was nothing like such bad conditions in Manchester, so far as lighting was concerned. He had seen no gas flares or fishtail burners for some time. In some of the waterproof factories in Manchester, however, glare was severe owing to the use of old-fashioned shades—a condition which, apart from the wastage of current, was prejudicial to the workers. It was the first time he had attended a meeting of the Illuminating Engineering Society. He thought there was a considerable field for educational propaganda before the Society, which deserved every encouragement. Such meetings were of great value to Inspectors of Factories. When the new Bill in which lighting was mentioned became known, public attention would be more drawn to the subject, and those interested in lighting should be prepared to meet new standards. He complimented Mr. Daniel on his paper.

Mr. SHAW (Manchester Association of Gas Engineers) said that, as a gas engineer, he was not particularly pleased with the examples of what gas lighting was like in the past, but agreed that Mr. Daniel was just the man to bring the matter forward. His opinions were very helpful, and the discussion of such matters should ultimately be to the benefit of the gas industry. He himself had had experience of the conservatism of masters. He recalled the case of a millwright who maintained that a naked gas flame on the centre of the work was the best means of illumination, as the intensity of the flame was so low that you did not get an after "image," and it was therefore easy to see the job. Nowadays, in some cases, the general illumination was so high that the human eye required a greater amount of local illumination, which brought us to the matter of comparison. Lighting required more study from the physiological point of view, especially in regard to avoidance of "glare." Good general plus local illumination formed the best for certain classes of work. Contrast also was important. He also thanked Mr. Daniel for a very interesting paper, and was sure that nothing but good would result from it. The matter of illumination did need attention in other places besides Sheffield.

Mr. R. C. HAWKINS (B.E.D.A.) said that, after hearing the paper, Sheffield did not sound too cheerful a town. He asked if Mr. Daniel could give any information on the "accident" side of the story. Was the percentage of accidents higher in these badly-lighted tenement factories than in other industries? Apart from actual accidents, did the majority of the workers under these conditions in Sheffield suffer a greater degree of fatigue? The question of the better lighting of these places was a problem that would have to be tackled in the near future. The matter was an easy one from the illuminating engineering point of view. Some factory owners in Manchester had been induced to improve their lighting conditions, which did good in providing comparison with poor methods, and went a long way towards solving the problem.

Mr. A. L. HOLTON (Manchester Corporation Gas Engineer) said that he remembered Sheffield well, and how early they commenced using gas. He knew of the very poor lighting conditions in some of the works, and did not think there was any like it in Manchester. There was room for plenty of educational work in this district. Lighting was a common ground on which gas and electricity could meet. He was pleased to note that both gas and electricity was used to advantage in some of the factories. It was interesting to note that during the Illumination Congress (1931), Sheffield was one of the towns visited, and he was then surprised at the poor examples of lighting exhibited.

Mr. MELLOR said it was particularly striking that Sheffield should be noted for its craftsmanship, and yet such poor lighting conditions prevailed. The paper was called "Some problems and their Solution." He certainly had heard of the problems but there was not much evidence of their solution, and he would have liked to have seen some cases where improvements had been made. He would like to see some examples of different types of lighting methods showing the benefits of each type, as he was sure there must be some good instances.

Mr. THORNLEY said that illuminating engineers were themselves responsible for a lot of the poor lighting. He went to one and obtained the best type of lighting equipment then available. As a result he had a good installation for about six months. After that time the reflecting material broke down through

corrosion between the enamel and the backing and the efficiency fell considerably. He was not encouraged to tackle the problem again.

Mr. VERITY (Manchester College of Technology) suggested that more publicity should be given to new illumination equipment. It was only quite recently that he heard that the old conical reflector was obsolete and that much better illumination results could be obtained with other, equally cheap, reflectors.

Mr. BALLARD (General Electric Co., Ltd.), referring to Mr. Thornley's comments on his equipment, stated that vitreous enamel reflectors had been improved considerably during the last few years, and were now considered to give very satisfactory service. He also stated that lighting with mercury discharge lamps was proving particularly effective. In addition to the higher efficiency, the colour of the light was helpful in detecting faults, etc.

Mr. J. SELLARS (Manchester Corporation) said that he had seen some of the lighting conditions in Sheffield. After seeing and hearing of the conditions still in existence he considered that no workers should be allowed to work under them. An employer was held responsible for other ailments and disabilities consequent on the poor working conditions, and should equally be held liable when faulty lighting caused illness or accident. There would probably then be an improvement in those conditions, for the sooner they were remedied the better for all concerned.

Mr. DANIEL, in reply, said that for his own part, he was not particular who was responsible for the lighting so long as it was good. The responsibility for defects lay largely with the system of "little-masters" and tenement factories. There might well be, however, other industrial centres as bad as Sheffield.

Replying to Mr. Shaw, he explained that the lantern slides showing a cobweb of gas pipes were the only slides he had, and were taken from photographs of working conditions. But there were a number of first-class gas-lighted factories in Sheffield. There would be less fatigue if more consideration was given to contrast in lighting. With regard to fatigue, he had no figures, but generally he found that the workers cared less about the lighting than the owners, or manufacturers, and the manufacturers were hit as a consequence of faulty lighting, before the workers. Replying to Mr. Mellor, Mr. Daniel stated that there were 100 factories in Sheffield which interested themselves in lighting and had made trials. When the trial installations were carried out, photometric readings were taken and owners were told exactly what results they were getting. With regard to defective reflectors, they had had trouble through fumes, etc., but had found the modern type much better all round, particularly the glass-covered type. Publicity was increasing. He had recently received a leaflet showing the difference between the old conical reflector, illustrated covered with cobwebs, and the more modern type, but suggested the addition of a few plain figures showing the savings, in the form of a table, which would be also helpful. Mercury vapour lamps were being used by some firms for the examination of the surface of stainless steel, and their use would no doubt be extended, especially when the smaller sizes were available.

In conclusion a hearty vote of thanks to Mr. Daniel was proposed by Mr. A. L. HOLTON (Manchester Gas Department) and seconded by Mr. KERR (Stretford Electricity Department), who remarked that the benefits of better illumination should be demonstrated to the manufacturer to be a proved matter of £ s. d. as well as the improved welfare of the workers.

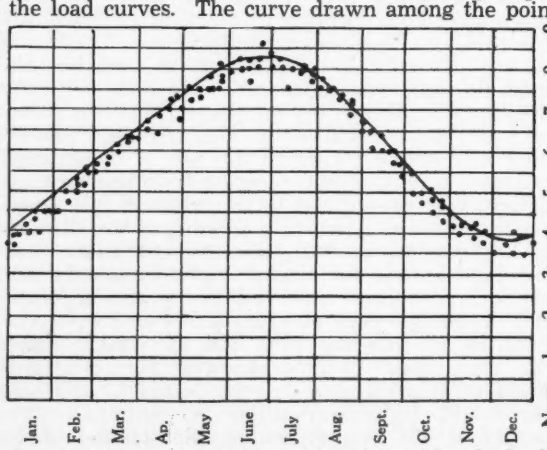
The "Lighting-Up" Time

Mr. G. H. Wilson's paper entitled "A New Lighting Up Time Table," read before the Association of Public Lighting Engineers last September, has brought us an interesting letter from Mr. A. P. Trotter, who recalls that it is just fifty and a half years since he contributed such a table to *The Electrician*. (Vol. xii., p. 38, May 24, 1884.)

Some ten years later, when he was Editor of that paper, he published an article on the subject (*Electrician*. Vol. 32, 1894, Jan. 19), showing how very closely the average time of lighting up seems to coincide with a few minutes before sunset, summer and winter. In what follows we reproduce an extract from the article, and the curve by which it was illustrated:—

"To-day we give an instance of one of the most regular laws of nature, and of the wonderful unanimity with which it is voluntarily obeyed by hundreds of different individuals. The time at which the light was turned on depended on two things, each peculiar to the special case. The one, the nature and amount of light wanted for the place, and the other, the judgment of one individual as to the extent to which daylight might diminish before artificial lighting became necessary. The first step towards a more general knowledge of the time during which artificial light is required, is to average a number of different cases, such as shops, private houses, etc., and the next step is to get the opinion of a considerable number of people instead of that of one man.

"Inspection of the load curve of a supply station enables us to supply both of these needs. It will be remembered that a load curve begins to rise slowly in the afternoon, then more rapidly as more lights are turned on, and, when the full load is approached, the rate of increase diminishes, and the curve becomes less steep. The steepest part of the curve evidently extends over that period of time during which the lights are being turned on at the greatest rate. Unless the load curve be of an unusual shape, it may be assumed, without appreciable error, that the middle point of the steepest part is the "average time of lighting up" for that district on that day. We are greatly indebted to the Westminster Electric Supply Corporation and to the St. James and Pall Mall Electric Light Company for the trouble which has been taken, at our request to furnish information on this subject. The diagram shows a number of points determined, as we have described, from the middle of the steepest part of the load curves. The curve drawn among the points



is the sunset curve, and the uniformity with which the points lie along it is rather striking. Each point is, as it were, the mean result of hundreds of independent voters, each of whom in turning on his switch, whether in shops or dwelling houses, basements or attics, unconsciously influenced the general result. The average time of lighting-up seems to be a few minutes before sunset, and the difference in the winter months is only just perceptible. The St. James and Pall Mall Company have sent us some observations for foggy days, but these are hardly sufficient to enable any definite results to be deduced. The number and duration of fogs to shift the mean curve a quarter of an hour for, say, two months, would be very considerable, and ought to be averaged over six or eight years."

Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

I.—RADIATION AND GENERAL PHYSICS.

1. Optical Factors in Caesium-Silver-Oxide Photo-electric Cells.

H. E. Ives and A. R. Olpin. J. Opt. Soc. Amer., 24, pp. 198-205, August, 1934.

The paper describes an investigation of the part played by the angle of incidence and state of polarisation of the exciting light in producing the enhanced or selective emission of photo-electrons in the red region of the spectrum. F. J. C. B.

2. Absorption of Light by Sea Water.

E. B. Stephenson. J. Opt. Soc. Amer., 24, pp. 220-221, August, 1934.

The absorption co-efficient* of sea water for sunlight was measured by means of a portable photometer in the conning tower of a submarine. The measurements were made at different depths in the open sea of the Pacific Ocean. No evidence of polarisation was observed, but selective absorption in the red was found at depths greater than 50 feet. F. J. C. B.

3. The Dependence of the Photo-electric Effect upon the Temperature at Very Low Temperatures.

R. Suhrmann and A. Schallamach. Zeits. f. Physik 91, pp. 775-791, 1934.

Using a photo-cell completely immersed (including the window) in a constant temperature bath, the dependence of the photo-electric effect upon temperature was investigated at room temperature, at that of liquid air and at that of liquid hydrogen. The photo-electric materials used were mirrors of beryllium, bismuth, and silver (the last-named covered with an atomic layer of potassium), which were obtained by vaporisation in a high vacuum. In agreement with theory the straight line deduced from the photo-electric total emission equation $J = M.T.r_e^{-e_0/k.T.r}$ is moved bodily parallel to itself towards smaller values when the temperature T is decreased. The work function r therefore remains unaltered. The constant M decreases with temperature in agreement with the new electron theories. Fowler's theory, and with it the new electron theory, is confirmed at low temperatures by the behaviour of the sensitivity curves of the beryllium and bismuth surfaces. The decrease in sensitivity upon cooling calculated from Fowler's formula agrees with the observed values in the immediate neighbourhood of the long wave limit; but with increasing distance from the long wave limit, there are increasing discrepancies which are probably due to electrons which are solidly bound to the metal lattice. The influence of the latter is also noticeable in the behaviour of the silver, potassium-covered surface. T. H. H.

4. Vision in the Ultra Violet.

H. Schober. Nature 134, p. 898, December 8, 1934.

Expresses the opinion that the continuous retrogression of the limit of visibility at the violet end of the spectrum with the age of the percipient is due to absorption not only in the crystalline lens of the eye, but also in the retina. T. H. H.

5. Huygen's Principle Applied to Cylindrical Waves.

J. Picht. Zeits. f. Physik, 91, pp. 717-723, 1934.

It is shown by mathematical theory that Huygen's principle is applicable not only to spherical waves but also, in a modified form, to cylindrical waves. Thus the cylindrical wave surface may be thought of as being divided into strips of infinitesimal width, each parallel to the axis of the cylinder. Each of these strips may be considered as a linear light-source emitting in its own turn elementary cylindrical waves, just as in the ordinary Huygen's principle each surface element of the wave surface will emit spherical waves. T. H. H.

II.—PHOTOMETRY.

6. The Light-Sensitive System of Greatest Technical Importance.

J. Eggert. Zeits. f. Techn. Physik, 11, pp. 436-443, November, 1934.

Considers the relative values of photographic, photo-electric, and photo-chemical methods for photometric purposes and compares them with the eye. W. R. S.

7. Electron-Tube Voltage Control for Photometry.

F. E. Kilpatrick and Carl P. Bernhardt. Electronics, 7, pp. 352-353, November, 1934.

The authors describe a system for controlling the voltage supply for photometric work, operated by means of thermionic valves. It is claimed that several photometers may be worked from the same source of supply with this method of control. S. S. B.

8. An Instrument for Continuous Record of Sunshine.

L. F. Miller. Rev. Scient. Instruments, 5, pp. 405-407, November, 1934.

The instrument consists of two evacuated bulbs, one of Pyrex glass and the other of Quartz. A thermocouple of enamelled copper wire is so arranged that one junction is in the glass bulb and the other in the quartz bulb. To the junction within the quartz bulb is attached a seamless, thin hollow-spun silver sphere, coated on the outside with lamp black. When the sun's radiation falls upon these bulbs the temperature of the quartz bulb will be raised above that of the glass bulb. The method of construction is described, and a number of reproductions of actual records are given. F. J. C. B.

9. Visual Spectrophotometry.

K. S. Gibson. J. Opt. Soc. Amer., 24, pp. 234-249, September, 1934.

The paper deals with typical instruments and methods, and the factors affecting the reliability of spectrophotometric data. F. J. C. B.

10. A Visual Thresholdometer.

M. Luckiesh and F. K. Moss. J. Opt. Soc. Amer., 24, pp. 305-307, November, 1934.

The instrument involves an arrangement whereby circular photographic films, placed directly in front of the eyes, may be rotated simultaneously by the turning of a knob. The density of the films increases uniformly from approximately 80 per cent. transmission to about 2 per cent. The subject wears the device as ordinary eyeglasses are worn, and slowly adjusts the controlling knob until the visual threshold of the object is reached. The scale of the instrument is arbitrarily calibrated in terms of the transmission of the films. A variety of practical uses of the device are cited. It may be used to determine the relative effectiveness of light from a gaseous discharge lamp and a tungsten filament lamp, and for many practical problems which involve the improvement in conditions of seeing. F. J. C. B.

III.—SOURCES OF LIGHT.

11. The Sodium Vapour Lamp; its Construction, Operation and Application.

H. Lingenfelsen. E.T.Z., No. 24, pp. 577-582, June 14, 1934.

Describes a two electrode sodium vapour lamp containing neon (or other rare gas) and sodium, and operating at 220 volts. The electrodes, which are impreg-

* Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, assisted in the compilation of abstracts during the past year: Miss E. S. Barclay-Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. J. G. Clark, Mr. L. J. Collier, Mr. H. M. Cotterill, Mr. J. S. Dow, Mr. J. Eck, Dr. S. English, Dr. T. H. Harrison, Capt. W. J. Liberty, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. R. Stevens, Mr. J. M. Waldram, Mr. W. C. M. Whittle, and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—Ed.

nated with readily emitting metallic oxides are heated by auxiliary transformers to start the discharge. The discharge takes place first in the neon, but after a few minutes, when the temperature of the gas has risen to its correct value, the characteristic yellow radiation of sodium appears. A choke must be connected in series with lamp to compensate for the negative resistance of the latter. The output of a 70 watt or 120 watt sodium-vapour lamp of this type is about 40 to 50 lumens per watt. The application of the lamp to street lighting, industry, and advertising is described and illustrated.

L. J. C.

12. A Steady Mercury Lamp for Use in Research.

A. L. Johnsrud. Rev. Scientific Instruments, 5, p. 408, November, 1934.

A capillary type of mercury lamp is described. It operates on the "low pressure" characteristic.

F. J. C. B.

13. Vapour Conducting Light Sources.

R. D. Mailey. Elect. Engineering, 53, pp. 1447-1449, November, 1934.

Developments in vapour conducting light sources made in European and American practice are outlined in this paper. The various types of sodium and other vapour arc lamps are considered, together with the principal factors affecting their operation.

14. Fundamental Electrical Properties of Mercury Vapour and Monatomic Gases.

Albert W. Hull. Elect. Engineering, 53, pp. 1435-144?, November, 1934.

Electrical properties of mercury vapour and monatomic gases are discussed from a theoretical standpoint. The elementary processes of excitation and ionisation of atoms are first considered, and then the electrical conductivity of gases under various conditions is discussed.

S. S. B.

15. The Testing of Cinematograph Carbons.

W. C. Till and F. S. Hawkins. G.E.C. Journal V., pp. 158-164, August, 1934.

The performance of carbon arcs for cinematograph projection is dealt with in detail, together with methods of measurement of the resulting illumination on the screen.

C. A. M.

16. Natural Gas Lighting in America.

American Gas Age Record, November 24, 1934.

Simultaneously with the exhibition of gas lamps at the Convention of the American Gas Association in Atlantic City, seven lights of 3,750 candle-power were turned on in front of the building of the Peoples' Natural Gas Company, thus marking the introduction of natural gas lighting in downtown Pittsburgh.

J. G. C.

IV.—LIGHTING EQUIPMENT.

17. The "Depressed" Beam of the Motor-car Headlight.—II.

L. W. Taylor. J. Opt. Soc. Amer., 24, pp. 287-291, November, 1934.

This is an extension of the author's previous theory, originally limited to the vertical axial plane, to cover the entire reflector. Computations on a representative headlamp reflector show the approximate limits of the region of anomalous behaviour of the "depressed" beam.

F. J. C. B.

18. New Forms of Luminous Publicity in Berlin.

M. Cohu. B.I.P., December, 1934.

Novel forms of luminous signs based on the use of electric discharge lamps, both sodium and mercury, are described. A novel feature is the combination with such lamps of reflecting surfaces coated with rhodamine and other fluorescent materials, whereby the possible range of colour is considerably extended.

J. S.

19. Daylight-control of Street Lights.

W. R. Weise and A. H. Lamb. El. World, 104, pp. 935-937, November 24, 1934.

This article gives a full account of tests made at Cincinnati, comparing the results of operating street-light switching photo-electrically with the hours of civil twilight and a modified schedule based on the hours of twilight.

S. S. B.

20. The Control of Light.

Anon. El. Times, 86, p. 623, November 15, 1934.

An account of a system by means of which comparatively large areas can be illuminated with a minimum number of electric lamps. The basis of the system is the use of parabolic reflectors to redistribute the light. The results are said to be excellent, and photographs are given.

W. R. S.

21. Time Intensity Relation and Spectral Distribution of Radiation of the Photo-Flash Lamps.

W. E. Forsythe and M. A. Easley. J. Opt. Soc. Amer., 24, pp. 195-197, August, 1934.

The time characteristics, the total amount of light, the maximum intensity, and the spectral distribution of radiation are given for a number of different flash lamps burning aluminium foil.

F. J. C. B.

22. Experiments with Gas Lighting in Hamburg.

Gas Times, December 8, 1934.

An account of experiments conducted in Hamburg with gas lamps equipped with special reflectors.

J. G. C.

V.—APPLICATION OF LIGHT.

23. Street Lighting.

H. Warren and L. J. Davies. Elect., 113, pp. 773-774, December 14, 1934.

A summary, with photographs, is given of a recent paper by the authors on the general application of discharge lamps to roadway lighting. The requirements for good street lighting are discussed, together with the relative merits of mercury and sodium sources.

C. A. M.

24. Safer Streets.

Anon. Elect., 113, pp. 775-776, December 14, 1934; Electrical News and Engineering (Canada), October 15, 1934.

A summary, with photographs and diagrams, is given of an article entitled "Why not Cheaper and Safer Streets?" which appeared in the Canadian journal mentioned. An analysis is based upon conditions in Ontario cities, dealing with the relation between reflectivity of street surfaces, illumination values, and accidents.

C. A. M.

25. Lights for vehicles in the meaning of the Reich's traffic regulation of May 28, 1934.

O. Höpcke. Licht u. Lampe, 23, No. 24, p. 559, November 22, 1934.

An explanation with diagrams of the new regulations (in Germany).

E. S. B. S.

26. Public Lighting with Gas.

Gas Times, November 24, 1934.

An illustrated article on public lighting with gas, containing useful diagrams and other data.

J. G. C.

27. Gas Lighting in Birmingham.

Gas Times, November 24; *Gas World,* November 24; *Gas Jour.,* November 21, 1934.

Describes the planning and installation of a Class "A" street lighting installation in Birmingham.

J. G. C.

28. Fundamentals for the Construction of Modern Light Advertisements.

H. Krüger. Licht u. Lampe, 23, No. 25, p. 581, December 6, 1934.

The author discusses the design and construction of light advertisements from a psycho-physiological basis. He first lists certain conditions which must be observed to make the advertisements attractive, and then deals with size, height, relief, brightness, and arrangement in more detail.

E. S. B. S.

29. Sodium Lighting for Buildings.

Anon. Elect., 113, p. 787, December 14, 1934.

A brief description, with a photograph, is given of a new flood-lighting installation in London, in which fifty-six floodlights are used equipped with sodium flood-lighting lamps.

C. A. M.

30. Tennis Court Lighting.

Anon. Elect., 113, p. 677, November 23, 1934.

A brief description, with a photograph, of lighting equipment for a tennis court, in which floodlights are suspended on 20 ft. poles.

C. A. M.

31. Waitomo Caves Lighting.

Anon. El. Times, 86, p. 681, November 29, 1934.

Some photographs and a description of the lighting in stalactite caves on the North Island, New Zealand. The effect is said to be very good.

W. R. S.

32. Garden Lighting with Gas.

Gas Times, November 17, 1934.

An illustrated description of the lighting with gas of the Tivoli Gardens at Copenhagen.

J. G. C.

Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

No. 417,747. "Improvements in or Relating to Electric Discharge Lamps."
Patent-Treuhand-Gesellschaft Für Elektrische Gluhlampen, M. B. H., December 21, 1932 (*Convention, Germany*).

This specification describes a table or like decorative lamp having two glow discharge tubes of different colour with one electrode vessel of each arranged in the base of the lamp and connected to terminals, the other two electrode vessels being connected together to place the tubes in series and carried wholly or partly by the tubes.

No. 417,986. "Improvements in or Relating to Electric Lamps."
The British-Thomson Houston Company, Limited, May 11, 1933 (*Convention, Germany*).

This specification describes a lamp for lantern-type signals having a lens or cover-glass and a reflector, which indicates the desirability of replacement while maintaining the signal. The lamp has a normal short-life filament in shunt with an extra long-life filament. An opaque band, or the like, is formed on or near the envelope which, when the normal filament burns out, interferes with the light from the other filament and casts a shadow on the lantern lens or cover-glass.

No. 418,128. "Improvements in Electric Arc Lamps."
The General Electric Company, Limited, August 24, 1933 (*Convention, Germany*).

This specification relates to enclosed arc lamps of the kind in which the arc passes through a gas containing cadmium vapour generated from a supply other than one of the main electrodes. According to the specification the envelope of the lamp is filled with a gas containing hydrogen, such as a mixture of 75 per cent. nitrogen, with 25 per cent hydrogen, at a pressure about 20 m.m. of mercury at room temperature. It is suggested that electrode sputtering is reduced.

No. 418,318. "Improvements in Lighting Fittings."
Campbell, G., and The Benjamin Electric, Limited, May 5, 1933.

This specification describes a mounting for the larger sizes of incandescent electric lamps in which the lamp-holder proper is carried upon a plate separated from an insulating terminal block by heat-dissipating supports which also serve as current conductors. These supports may be surrounded by a shield, and they may extend beyond the holder and carry a supplementary reflector within a main reflector supported by the shield.

No. 418,375. "Improvements in or Relating to Gas Burners, Particularly for Use in Street Lighting."
Kempton, C. H. A., and Parsons, E. H. P. M.

This specification describes an incandescent Bunsen-type gas-burner which may be readily dismantled for cleaning. The gas nozzle is in the form of a tapered plug, and is inserted into a tapered socket in the end of the Bunsen tube. The plug projects from the end of the socket and the projecting portion has an annular groove to receive a projection carried by a co-axial screw cap, which is freely rotatable and capable of limited movement in relation to the plug. The screw cap, by engagement with the socket and plug respectively, retains these parts in engagement, but permits separation when desired.

No. 418,484. "Improvements Relating to Head Lamps for Road Vehicles."
Guicherd, L., March 4, 1933, *March* 24, 1933 (*Convention, France, Cognate Applications*).

According to this specification an ordinary projector and one with total occultation are combined within a common casing. The ordinary projector may comprise the upper half of a parabolic reflector and a lamp having its lower hemisphere silvered. The totally occulting projector, which may be located in the lower part of the casing, may comprise a reflector, a lamp adjustable vertically, a screen or mask masking the lower half of the reflector, and an anterior screen or mask masking the upper half of the reflector and affording a window for the passage of the beam of light from the reflector.

Another specification of the same Applicant, No. 418,567, refers to a totally occulting projector which is an improvement on, or modification of, that described in an earlier Specification, No. 398,398.

No. 418,662. "Improvements in Miners' and Other Portable Lamps."
Hailwood, A. E., January 25, 1934.

According to this specification a portable lamp is equipped with a luminous discharge tube and has extra external terminals by which the discharge may be started from an external source of high voltage, after which the discharge is maintained by a battery housed within the lamp.

No. 418,845. "Improvements Relating to Electric Discharge Lamps."
Siemens Electric Lamps and Supplies, Limited, Dobrulux, Limited, and Aldington, J. N., July 1, 1933.

According to this specification the discharge in a glow discharge lamp for alternating current is caused to move irregularly or to gyrate by forming the electrodes symmetrically about the virtual axis of the glowing layer of gas and spacing them apart at a small distance by solid insulation, one of the electrodes being a tapering surface of revolution and having an active surface considerably greater than that of the other electrode.

No. 418,989. "Improvements in and Relating to Electric Lamp Filaments and Methods of Manufacturing the Same."
Erber, B., May 7, 1932 (*Convention, Austria*).

This specification proposes a lamp filament consisting of a carbon core coated with tantalum carbide, both of which have very high melting points, so that the filament may be run at a much higher temperature than is usual. The coating of tungsten carbide prevents diffusion of the carbon.

No. 419,233. "Improvements in and Relating to the Construction of Light Sensitive Cells."
Fitzherbert, H., and Hughes, H. G., August 31, 1933.

This specification suggests that the pinch or foot of a photo-electric cell should serve as the support for the sensitive material.

The Evolution of the Sinusoidal Diagram and Horizontal Illumination Charts

by Wm. J. G. DAVEY, B.Sc. *(Research Illuminating Engineer, Messrs. W. Parkinson & Co.)*

Paper presented at the Eleventh Annual Meeting and Conference of the Association of Public Lighting Engineers, held in Aberdeen during September 17th to 20th, 1934.

The extended use of directional reflectors has caused a minor revolution in photometric methods and street lighting calculations.

With a symmetric fitting, the distribution of candle power, determined by the somewhat leisurely, not to say tedious, use of the bar photometer, could be shown on a single polar curve. The mean hemispherical candle power and total lumen output were closely related to this polar curve, and easily calculable. The determination of test-point illumination was simple, as the candle power was uniform through any horizontal plane. The average illumination on a street could be easily calculated by such formulae as that of Stiles. Moreover, the preparation of iso-lux diagrams to represent the distribution of illumination over a street was straightforward, as each iso-lux line from a particular unit comprised a circle with the light source as centre.

The use of directive fittings, however, has complicated matters. A multiplicity of polar curves are necessary to show the distribution of candle power.

Integrating spheres and cubes are required, to determine lumen output without involved calculation. The determination of test-point illumination requires a consideration of candle powers at different azimuthal angles. The calculation of average illumination is extremely difficult without some form of equi-areal projection, while the representation of the distribution of horizontal illumination by means of iso-lux diagrams becomes, using the standard methods, a very long and tedious process.

The sinusoidal diagram, which had already been extensively used by geographers and astronomers, was called into service as a convenient method of representing the distribution of candle power, and is applicable also to the calculation of average illumination. It has been fully described from the mathematical and non-mathematical points of view during the past few years, and may be regarded as a contour map, incorporating the multiplicity of polar curves which represent the distribution of candle power from a directive light source, on a single chart.

The model, Figure 1, may serve to illustrate the relationship of the sinusoidal diagram to the polar curves from whence it is derived. M.1 is a solid model, showing the wave front of candle power distribution of a 4-light alignment burner (No. 2 mantles), in an 18-in. square lantern, and fitted with Mor-lite directional reflectors below the burner. The reflectors are adjusted to throw their maximum beam at right angles to the line of mantles, i.e., at the same azimuthal angle as the maximum beam from the alignment burner, and at an angle of 15 degrees below the horizontal. Candle powers from 0-100, 100-200, etc., are differently shaded. A vertical radial section of the model at any azimuthal angle gives the polar curve at that angle. Thus, D.1 shows the polar curve of the fitting at 0 degrees azimuth, and is the section which would be produced if the model M.1 were cut at that angle.

D.2 shows the candle powers at 0 degrees azimuth plotted on ordinary graph paper instead of polar paper. If such curves for the series of azimuthal angles are spaced at distances representing the azimuthal angles to which they refer, the wave front which they enclose is shown in M.2.

A contour map of this model is shown in D.3. The lower edge of the model M.2 and diagram D.3 represents a position at 90 degrees from the horizontal, i.e., immediately beneath the lamp. All the points along this line are, therefore, coincident, and are made so in diagram D.4, which comprises the lower half of the sinusoidal diagram of this fitting.

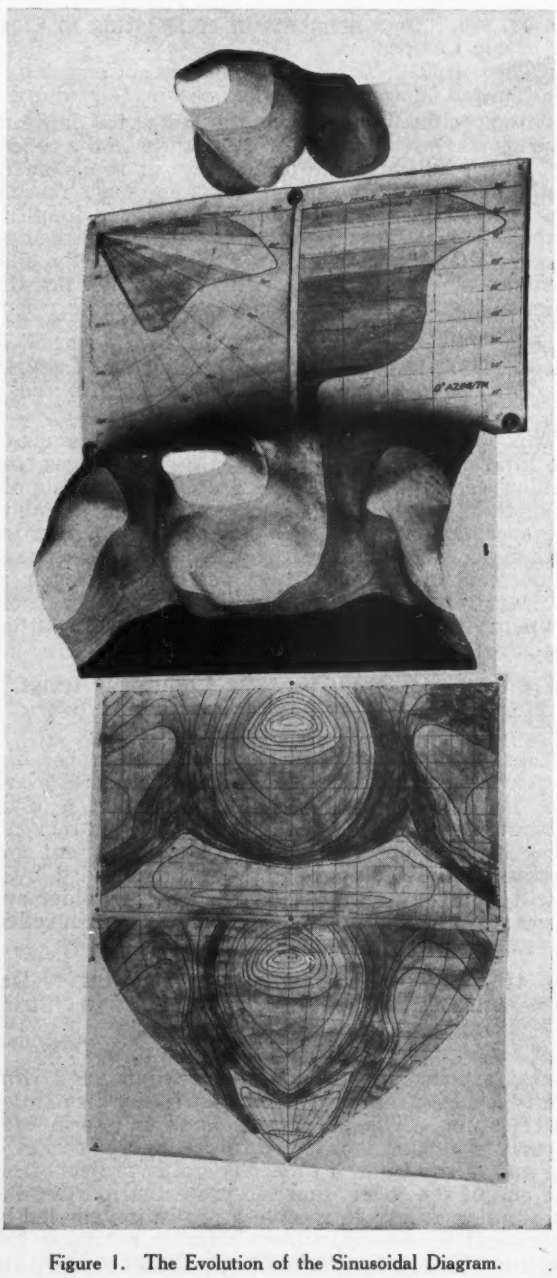


Figure 1. The Evolution of the Sinusoidal Diagram.

THE USE OF THE PHOTO-ELECTRIC CELL.

The determination of candle powers for the preparation of the sinusoidal diagram is, with any form of subjective photometer, a lengthy and tedious process, causing considerable eye-strain. The thirty to forty readings necessary for the determination of a polar curve must be multiplied to about four hundred in the case of a sinusoidal diagram. Fortunately, there are objective photometers, in the form of photo-electric cells, which speed up the candle-power determinations, and involve no eye-strain other than that occasioned in reading a galvanometer scale. If the photo-cell is calibrated before and during a test, using the subjective photometer, the results may be obtained with a satisfactory degree of accuracy. In the Parkinson laboratories the photo-cell is fitted to a hoop, revolving round the lamp, so that the sensitive surface is always normal to the light source.

The advantages of this form of photometer will be further appreciated when it is realised that if adjustable reflectors are fitted to an already directive fitting, a different sinusoidal diagram will have to be prepared for each adjustment of the reflectors, and, consequently, for each new street-lighting scheme, until sufficient data has been obtained to assess the respective influences of directive fitting and adjustable reflector upon the candle-power distribution.

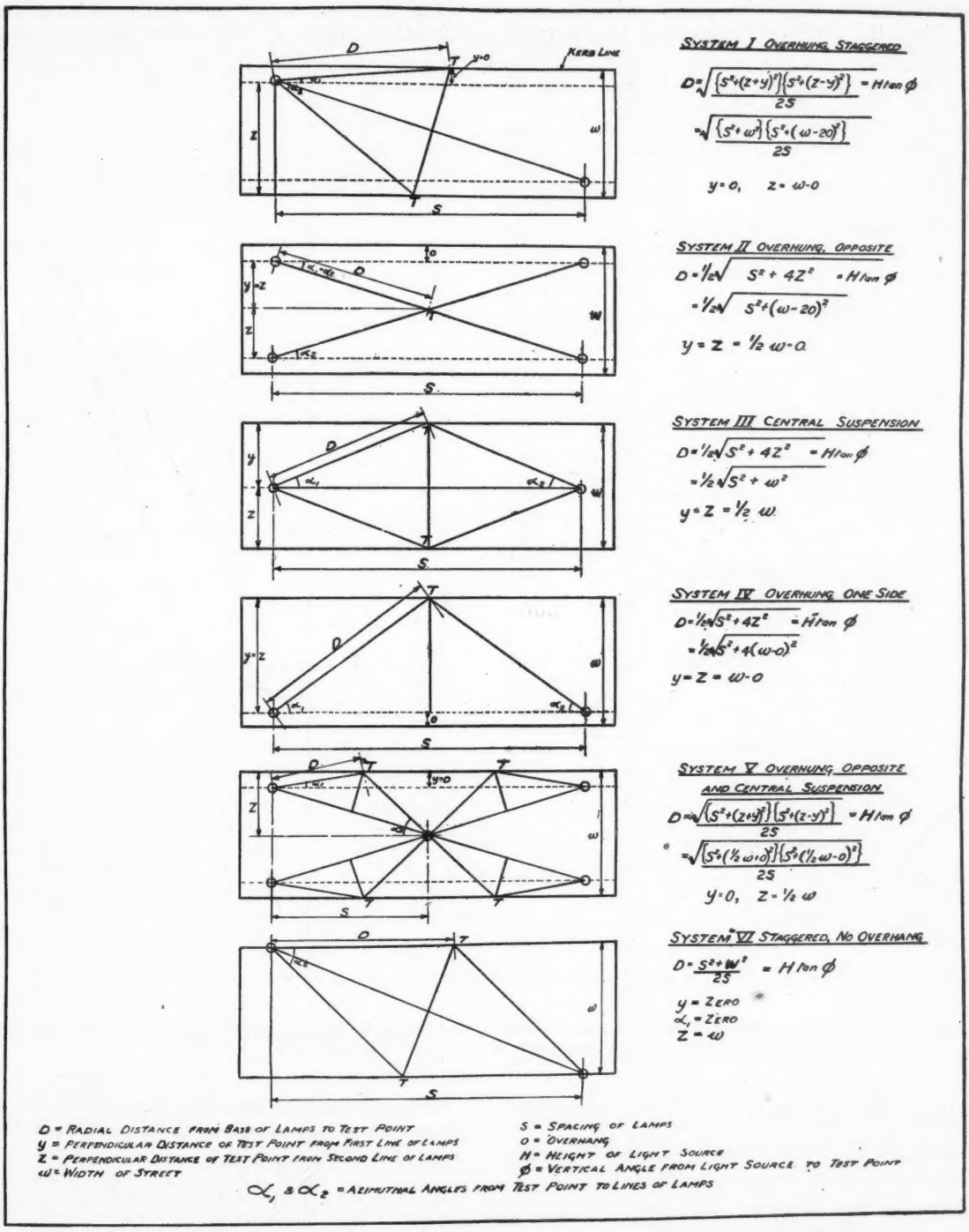

SYSTEM I OVERHUNG, STAGGERED
SYSTEM II OVERHUNG, OPPOSITE
SYSTEM III CENTRAL SUSPENSION
SYSTEM IV OVERHUNG ONE SIDE
SYSTEM V OVERHUNG OPPOSITE AND CENTRAL SUSPENSION
SYSTEM VI STAGGERED, NO OVERHANG
KERB LINE
D = RADIAL DISTANCE FROM BASE OF LAMPS TO TEST POINT
y = PERPENDICULAR DISTANCE OF TEST POINT FROM FIRST LINE OF LAMPS
Z = PERPENDICULAR DISTANCE OF TEST POINT FROM SECOND LINE OF LAMPS
ω = WIDTH OF STREET
S = SPACING OF LAMPS
O = OVERHANG
H = HEIGHT OF LIGHT SOURCE
φ = VERTICAL ANGLE FROM LIGHT SOURCE TO TEST POINT
α1 & α2 = AZIMUTHAL ANGLES FROM TEST POINT TO LINES OF LAMPS

Figure 2. Assembly of Diagrams and Formulæ forming the basis of Calculations of Illumination.

TEST-POINT ILLUMINATION.

A method has been developed in the Parkinson Laboratories which enables test-point illumination to be calculated without the necessity of drawing a plan of the installation. Given the system of illumination, the spacing, the overhang, the width of the street, and the height of the lamp, all the necessary data is available for calculating the vertical and azimuthal angles subtended from the lamp to the test-points. Thus the radial distance from the lamp to the test-point may be determined from the general formula:—

$$D = \frac{\sqrt{(s^2 + w^2)\{s^2 + (w - 2O)^2\}}}{2s} \quad \text{.....(1).}$$

where s = the spacing,
w = the width of the road,
o = the overhang, and
D = the radial distance from the base of the lamp to the test point.

Formulae derived from the above may be obtained for all the usual systems of lighting, as shown in Figure 2.

The perpendicular distances W, from the plane of the lamp parallel to the street, to the test-points, are also given as y and z, in Figure 2.

The vertical angle ϕ is calculated from the formula $D = H \tan \phi$, where H = the height of the lamp,

$$\text{or } \phi = \tan^{-1} D/H \quad \text{.....(2),}$$

and the azimuthal angles α_1, and α_2, from the formula

$$W = D \sin \alpha,$$

$$\text{or } \alpha = \sin^{-1} W/D \quad \text{.....(3)}$$

The candle-power for the vertical angle ϕ, and the azimuthal angles α_1 and α_2, are read off from the sinusoidal diagram, and the sum of these candle-powers is multiplied by $\cos^3 \phi / H^2$, to obtain the test-point illumination, E^t.

$$E_t = \{ I\phi(\alpha_1) + I\phi(\alpha_2) \} \cos^3 \phi / H^2 \quad \text{.....(4)}$$

Formulae (2), (3), and (4) may be solved by means of the nomographic chart, Figure 3.

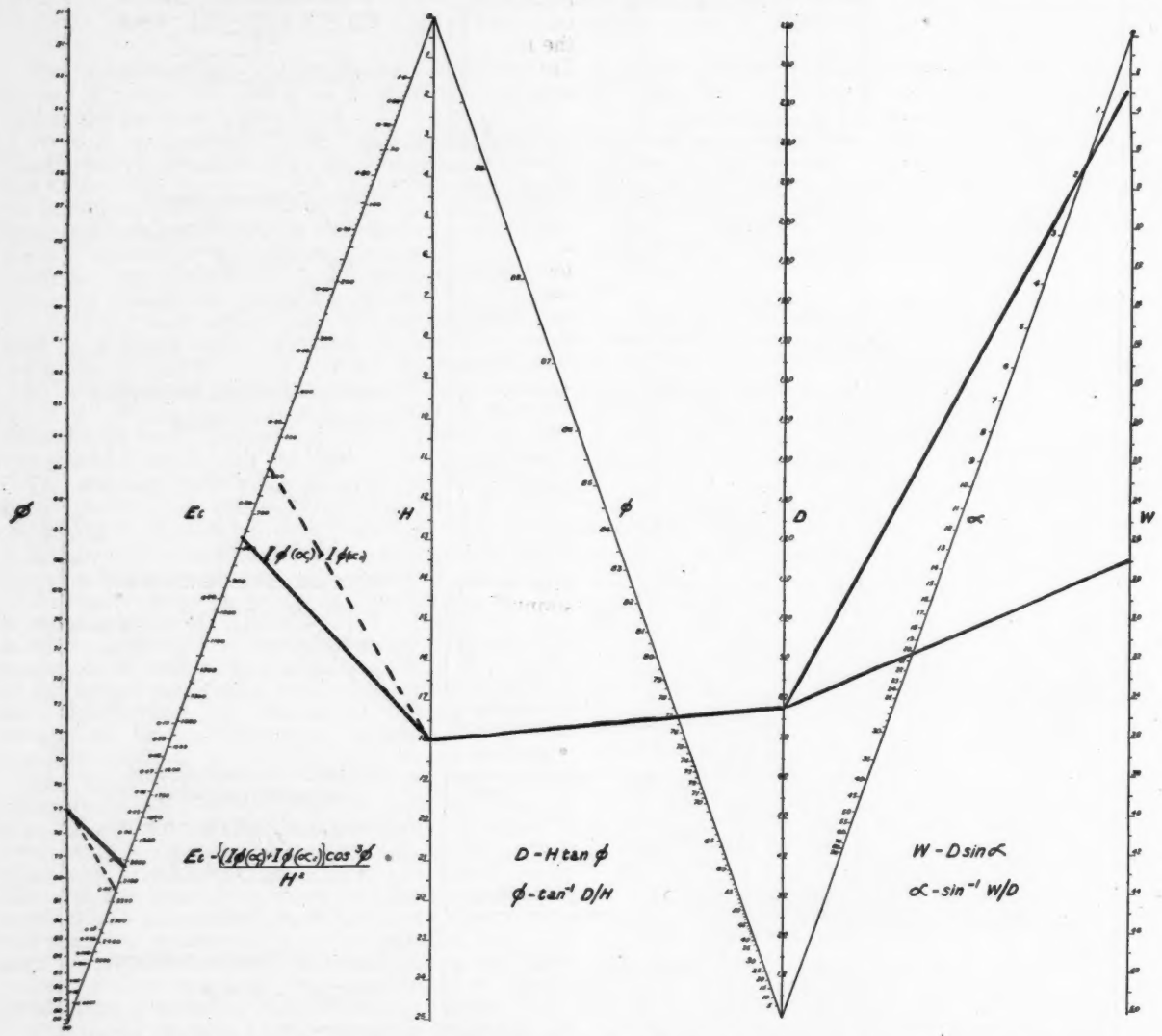


Figure 3. Charts enabling (*a*) requisite candle-power to ensure a certain test-point illumination and (*b*) the test-point illumination corresponding to specified candle-powers and angles of inclination to be determined.

An actual example will best illustrate the use of the Parkinson Charts. Suppose that we have a staggered system with lamps overhung 3 feet into the road. The width of the road is 30 feet, and the spacing 150 feet. The mounting height of the lamps is 18 feet.

Referring to Figure 2, we have for system I Overhung, staggered,

$$D = H \tan \phi = \frac{\sqrt{(s^2 + w^2)\{s^2 + (w - 2O)^2\}}}{2s.}$$

where s = spacing = 150 feet.
w = road width = 30 feet,
o = overhang = 3 feet,
and H = height of lamp = 18 feet.

This formula becomes

$$D = H \tan \phi = \frac{\sqrt{(22{,}500 + 900)\ (22{,}500 + 576)}}{300}$$
$$= 77.45$$

It is next necessary to determine the azimuthal angles α_1 and α_2, and the vertical angle ϕ. The azimuthal angles are calculable from the formulae.

$$\alpha_1 = \sin^{-1} W_1/D$$
and $$\alpha_2 = \sin^{-1} W_2/D$$
where D = H tan ϕ = 77.45.
W_1 = y = o = 3,
and W_2 = z = w - o = 27.

They may be obtained by the use of the right-hand chart, Figure 3. Thus, to determine α_1, a line is drawn from the point 77.45 on Scale D to the point 3 on Scale W. This intersects the oblique Scale α at 2 degrees, = α_1. To determine α_2, a line is drawn from the point 77.45 on Scale D, to the point 27 on Scale W. This intersects the oblique Scale α at 20½ degrees = α_2.

The centre Chart is used for determining the vertical angle ϕ, which is calculable from the formula

$$\phi = \tan^{-1} D/H$$
where D = 77.45
and H = 18.

A line is drawn from the point 77.45 on Scale D to the point 18 on Scale H. This intersects the oblique Scale ϕ at the point 77° = ϕ.

The left-hand chart may be used for two purposes: (1) to determine the aggregate candle power necessary at ϕ degrees to obtain a given test-point illumination; (2) to determine the test-point illumination obtainable from a fitting when the candle-powers at the vertical angle ϕ, and the azimuthal angles α_1 and α_2 (read off from the sinusoidal diagram of a given fitting) are known.

(1) The dotted lines on the left-hand chart show how the aggregate candle power necessary to give a test-point illumination of 0.02 foot-candles is determined. The actual formula will be

$$\Sigma I\phi = \frac{E_t H^2}{\cos^3 \phi} \quad \text{.....(5)}$$

where $\Sigma I\phi$ = the sum of the candles from the two lamps,
H = the mounting height = 18 feet.
E_t = test-point illumination = 0.02.
and ϕ = the vertical angle from the light source to the test-point = 77 degrees.

A line is drawn from the point 77 on Scale ϕ on the extreme left-hand side of the chart to the point 0.02 on the oblique Scale E_t. A second line, parallel to the first, is then drawn from the point 18 on Scale H. This intersects the oblique Scale I ϕ at a point 570, which represents the required candle power.

(2) The test-point illumination with a given fitting may be determined as follows: Assume this fitting to be the lamp whose candle-power distribution forms the subject of the model, Figure 1. The candle-power at the vertical angle ϕ = 77 degrees is, for the azimuthal angle α_1 = 2°, 470, and for the azimuthal angle α_2 = 20½°, 300. The total candle power directed to the test-point is therefore 470 + 300 = 770. A line (unbroken in Figure 3) is drawn from the point 18 on Scale H, to the point 770 on the oblique Scale $I\phi\ (\alpha_1) + I\phi\ (\alpha_2)$. A second line is then drawn from the point 77 on Scale ϕ, parallel to the first line. This intersects the oblique Scale E_t at 0.027, which is the required test-point illumination in foot-candles.

The calculated figures are compared with those obtained from the chart, in Table (1).

Other charts have been developed in the Parkinson Laboratories, for the simplification of iso-lux diagram preparation, and the calculation of average illumination, but I have not the time to demonstrate these. Sufficient has perhaps been said to show that nomographic methods may be usefully applied to the simplification of street-lighting calculations, or, as one user of the charts has put it, "to take the sigh out of scientific illumination."

Table (1)

		Calculated	From Chart.
$\alpha_1 = \sin^{-1} 3/77.45$	=	2°	2°
$\alpha_2 = \sin^{-1} 27/77.45$	=	20½°	20½°
$\phi = \tan^{-1} 77.45/18$	=	77°	77°
$\Sigma I\phi = \frac{E_t H^2}{\cos^3\phi} = \frac{0.02 \times 324}{0.0114}$	=	568	570
$E_t = \frac{I\phi \cos^3\phi}{H^2} = \frac{770 \times 0.0114}{324}$	=	0.0271	0.027

Street Lighting in Liverpool

The annual Report of the City Lighting Engineer in Liverpool (Mr. P. Robinson) emphasises two features which apply alike to the gas and electric lighting, (1) the continued equipment of main streets with devices which help to reduce glare and increase visibility, and (2) the use of 2-light fittings in lamps extinguished after 11.30 p.m. By extinguishing one of the lamps or burners only the uniformity of the illumination is not impaired, as is inevitably the case when alternate lamps are turned out. We notice that a considerable number of reinforced concrete lamp columns and lighting poles have been recently introduced.

A valuable feature of this report is the series of comparative statistics covering the years 1893 to 1933, which appear in the appendix. It is pointed out that during this period the mileage of streets lighted has increased by 231 per cent., and the number of lamps by 134 per cent. At the same time the total illuminating power in candles has increased by 1,354 per cent. and the candle-power per linear mile of street by 336 per cent.

In view of these results it is surely an indication of the care exercised by the department that the total expenditure on street lighting has increased by 182 per cent. only, and the lighting rate by 48 per cent. only—whilst the average cost per mile of street has actually *decreased* by 14.7 per cent.

636021

Modern Street Lighting

With Special Reference to Safety on the Roads

(Notes on the Presidential Address delivered by Mr. Clifford C. Paterson before the Junior Institution of Engineers on December 14, 1934)

MR. C. C. PATERSON'S address presented in an exceptionally complete form the essentially modern view that road brightness, gained by the judicious use of polished reflection from the road surface, is the predominant consideration in determining visibility in the streets. The address was illustrated by an excellent series of lantern slides.

In the lecturer's opening remarks reference was made to the progressive increase in the number of licensed motor vehicles, which doubled between 1922 and 1928, and has now attained a total of approximately two and a quarter million. Street lighting, of course, plays the part of assisting the police in the suppression of crime, but its main function is to give safety to cars, lorries, and pedestrians, and if it does this it will certainly fulfil the requirement mentioned above.

Contrast Between Day and Night.

In approaching the subject from the standpoint of the safety of the users of the road, it is natural to consider *firstly* the dangerous conditions from which street lighting must protect us, *secondly* the factors which make for good and bad seeing, and *thirdly* the trend of design to meet the requirements of good seeing. Mr. Paterson illustrated the disparity between the intensity of street lighting available by night and day by means of an ingenious diagram The height of Mount Everest was used as a measure of the 8,000 ft.-candles provided by good daylight "Reasonable street lighting" (say 0.2 ft.-candle) is then shown by the size of a molehill, moonlight (0.02) by the height of the mole that makes the molehill, and badly lighted streets (0.01 and under) by "the dignified height of a worm cast."

Importance of Contrast.

Bearing in mind the relatively low illuminations possible by artificial light, and the adaptation of the retina of the eye thereto, the only way in which to improve seeing is to accentuate the contrasts. Numerous lantern slides (some portraying the famous example of the black and grey cats) served to emphasise the conclusion that it is by silhouette —by contrast with the bright background of the road-surface—that objects are seen. Almost all objects that one meets on the roadways at night are of relatively low reflection value. The conclusion, therefore, is "make the road surface as bright as possible" —there is no other solution. It is true that a motor-car headlight operates by illuminating the object—by making it brighter than the road. But a projector giving 20,000-30,000 candles, and producing a vertical illumination far beyond that practicable by ordinary methods of street lighting is then necessary.

Uniformity of Road Brightness.

It is true that most road-surfaces, like the objects upon them, are dark in quality. But this is largely offset by the tendency of such materials to become polished—a condition of which the designer of modern street lighting installations can take good advantage. Numerous diagrams were presented to illustrate this fact. It was pointed out, for example, that it is mainly the rays of distant street lamps and the light emitted at angles of 1°-15° below the horizontal that contributes to the visibility at the point where the motor driver most wants it. Naturally road surfaces show considerable variations in quality. But it was suggested that in general the variation is not sufficient to cause serious embarassment. On long straight roads it is frequently possible to obtain an uninterrupted path of light along its whole length, and for an expenditure of 3 watts per foot run a brightness equivalent to 0.5 foot-candles as seen on a white surface. One interesting conclusion in this connection is that the proportion of the road likely to be light is equal to "height of post/height of post + height of eye of observer," and is thus independent of the width of the road. It can also be shown that whilst the proportion increases as the height of the post increases no substantial advantage is gained by increasing the mounting height beyond 25 ft. This line of reasoning also suggests that installations of lamps over the centre of the roadway are in general at a disadvantage as compared with roads lighted at the sides. The former method gives the effects on the parts of the road where they are least needed.

Effects of Glare.

Side lights, and still more, headlights of approaching cars, are liable to depress to a dangerous extent the appreciation of the eye to contrasts. There is something to be said for the switching off of *all* car-lights on roads, the degree and uniformity of brightness of which is sufficient to give ample visibility. In this connection, also, the fact was emphasised that the impression of glare produced by a street lighting unit depends in a very great degree, on the conditions of road-brightness. In other words, considerable brightness on the part of the light-source is much more tolerable if the level of brightness of the adjacent road surface is also high.

The British Standard Specification.

As a preliminary to a discussion of the trend of modern installations the author recalled the classification of streets in terms of minimum illumination as contained in the British Standard Specification. In defence of the specification it is pointed out that one cannot specify in terms of road brightness, unless the characteristics of the road surface as well as the lighting installation can be guaranteed. Moreover, the use of minimum illumination (rather than watts or therms per hour per foot run of street) is an advantage, in that it encourages a distribution of light favourable to the use of specular reflection.

Spread Specular and Diffuse Reflection.

The two alternative systems, road brightness by (a) spread specular, and (b) diffuse reflection, are the only two guiding principles in modern street lighting which are worth consideration. As good examples of the "diffusing" type of installation two Continental roads, one German, and the other Dutch, were described and illustrated. In both cases the aim is to send all possible down on to the road, not along it. Light from the bare lamp is prevented from being directed along the road at angles nearer the horizontal than 20°. There is no danger of glare, and to the car driver the road brightness is about 1/30 equivalent foot-candle. Close spacings of lamps, in one case 80 ft., and in the other 66 ft. are used. Lamps are somewhat over 30 ft. high. The Germans have an interesting arrangement of posts 300 ft. apart, bridged by a span wire from which lamps are hung at intervals. In contradistinction, examples of installations on English roads using the spread specular reflection system were described. The Victoria Embankment and to some extent Whitehall illustrate this method. Instances of bad conditions approaching "beacon lighting" were also given. It is pointed out that on wet roads, considerable use of the spread specular reflection method is essential if satisfactory brightness of the road surface is to be achieved.

Costs.

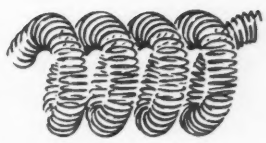
In the concluding part of the address the question of costs was touched upon. It was suggested as possible that an average road brightness of 0.5 equivalent foot-candle might be attainable with a Class D installation (min. illumination 0.2 ft.-c.) or even a Class E specification.

UP TO 20% MORE LIGHT

FROM

The new Mazda Gasfilled COILED-COIL Lamps—the latest discovery of the Mazda Research Laboratories—will give you more light with no additional cost for lamps or current.

Mazda Coiled-Coil Lamps are supplied in Pearl, Clear and Opal bulbs, in the following sizes:—
40 watts, 60 watts, 75 watts, 100 watts
at the same prices as ordinary gasfilled lamps.



This special double-wound filament, by reducing heat losses, gives an increased efficiency of from 10% to 20% according to size.

MADE IN ENGLAND

B T-H

MAZDA

GASFILLED
COILED-COIL LAMPS
WITH THE WONDERFUL NON-SAG FILAMENT

3547 A

THE BRITISH THOMSON-HOUSTON COMPANY. LTD.

New Fittings for Electric Discharge Lamps

At the opening meeting of the Illuminating Engineering Society in October last the new 250-watt size of Osira lamp introduced by the General Electric Co., Ltd., was on view, and the general progress in discharge lighting with these lamps was described. It is stated that the efficiencies have been progressively raised to a value of 42½ lumens per watt for the 400-watt lamp, and 36 lumens per watt for the 250-watt lamp.

Some interesting auxiliaries for use with the Osira lamps were also exhibited by Mr. E. L. Damant, who stressed the fact that the characteristics of these lamps must be considered in conjunction with the special chokes which the General Electric Co., Ltd., have developed. A steady advance in the electrical and mechanical characteristics of these chokes had been recorded during the year.

Mr. Damant showed a new range of outdoor industrial units designed for the Osira lamp incorporating a new weather and condensation proof top connecting box and a heat-resisting dustproof screw-neck well-glass. The body of these fittings is standardised and different types of reflector are available for various distributions. A new diffusing unit for Osira lamps comprised a stepped opal globe of 3-ply high transmission flashed opal which was designed for the conversion of "Wembley" Lanterns from filament lamps to Osira lamps. A similar conversion unit was the G.E.C. one-piece Prismatic Diffuser-Refractor in which the patented principle of the combination of prismatic refractor with a fluted diffuser (as originally employed in the Watford Road lanterns) was combined in one piece of accurately pressed glassware.

Some of these new fittings are illustrated in Figs. 1-6.

Figure 1. Angled Reflector for use with electric discharge lamps.

Figure 2. The Dispersive type of Fitting.

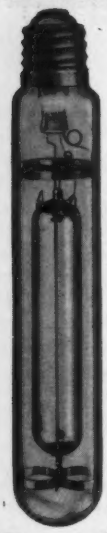


Figure 4. The improved Osira Lamp. The 400 watt type furnishes 17,000 lumens and the 250 watt type 9,000 lumens.

Figure 3. The Extensive Unit.

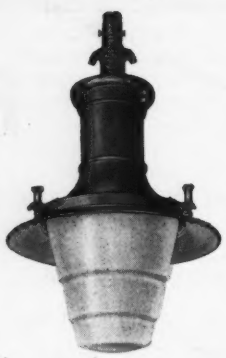


Figure 5. Opal Dispersive Lantern.

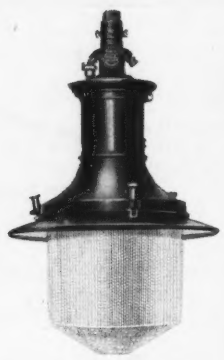


Figure 6. One-Piece Diffuser Refractor Lantern.

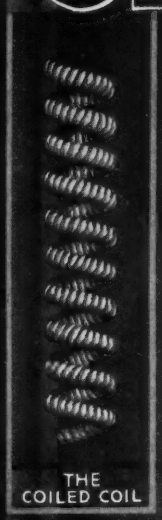
NEW G.E.C. RANGE OF OUTDOOR INDUSTRIAL (250 WATT AND 400 WATT) UNITS FOR USE WITH OSIRA LAMPS. A SPECIAL FEATURE IS THE NEW PATENTED WEATHERPROOF TOP.

Sheffield Illumination Society

We learn that the programme of the above society, which is now completed, includes an Annual Dinner and Concert, Visits to the Mining Department, Sheffield University and to the Dairy of the Sheffield and Eccleshall Co-operative Society, and Lectures on "The Way the Money Goes" (Mr. R. Parker) and "What is Electricity?" (Mr. N. Schofield). The Annual Outing, to Blackpool, will take place in June. It may be recalled that the Founder and Hon. President of the Society, formed for the benefit of employees of the Corporation Lighting Department, is Mr. J. F. Colquhoun (the Public Lighting Engineer for Sheffield). The existing officers are Mr. A. L. Williams (President), Mr. W. G. Brookfield (Vice-President), and Mr. E. Marrison (Hon. Secretary).

A View of the Anti-Aircraft Searchlight which has just been supplied to a Far Eastern Government by The London Electric Firm (of South Croydon).

ONE GOOD THING LEADS TO ANOTHER



CRYSELCO
COILED COIL LAMPS
NOW AVAILABLE
IN FOUR SIZES
200 - 260 VOLTS

MADE IN BEDFORD

EXTRA LIGHT AT NO EXTRA COST and the SAME GUARANTEED LIFE.

Feature these lamps now, tell your customers about them, how they can get that extra light in their rooms at no extra cost—it means profit to you.

40 watt	20% more light *Pearl or Opal*	1/9 Pearl
60 watt	15% more light *Pearl or Opal*	1/9 Pearl
75 watt	12½% more light *Pearl or Opal*	2/6 Pearl
100 watt	10% more light *Pearl, Opal or Clear.*	2/6 Pearl

CRYSELCO LAMPS

Three years ago

WESTON offered the first practical photo-electric illumination meter in the form of its Model 603.

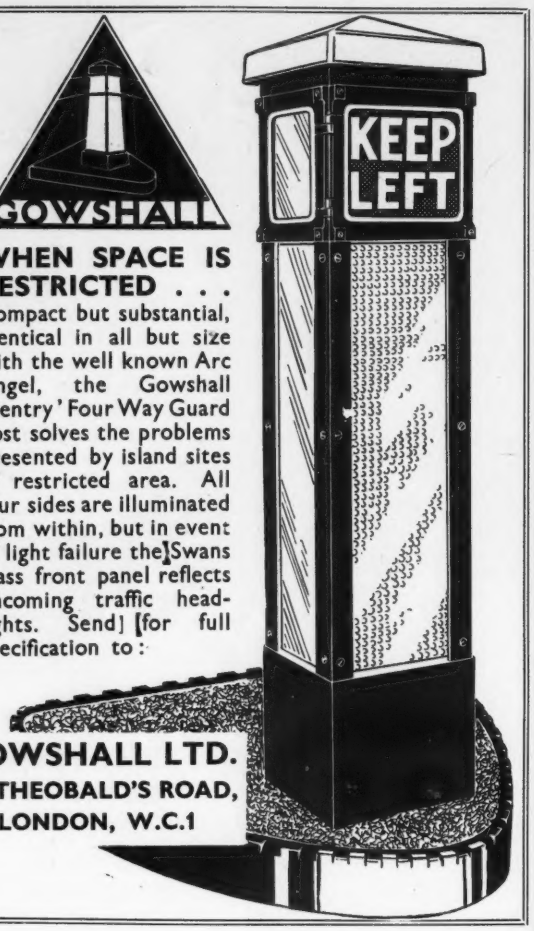
During this period the Model 603 has proved its usefulness and reliability in all fields of illumination, and has been universally adopted by undertakings throughout the country, who have learned to rely implicitly on the unfailing accuracy and unchanging characteristics of this instrument. Its ruggedness and accuracy make it suitable for use both in the laboratory and in the field. The unskilled observer as well as the technician can obtain accurate results from this instrument. The WESTON Illumination Meter is built to give the continuous dependable service expected of WESTON products.

WESTON
Standard the World over
PIONEERS SINCE 1888

Announcement of the
WESTON ELECTRICAL INSTRUMENT Co., Ltd.
Kingston Bypass, Surbiton, Surrey.
'Phone : Elmbridge 6400-01. 'Grams : " Pivoted, Surbiton."

GOWSHALL

WHEN SPACE IS RESTRICTED . . .
Compact but substantial, identical in all but size with the well known Arc Angel, the Gowshall 'Sentry' Four Way Guard Post solves the problems presented by island sites of restricted area. All four sides are illuminated from within, but in event of light failure the Swans glass front panel reflects oncoming traffic head-lights. Send for full specification to :



GOWSHALL LTD.
49, THEOBALD'S ROAD, LONDON, W.C.1

A BOOK FOR THE POCKET

ELECTRIC WIRING TABLES

By W. Perren Maycock, M.I.E.E.. Sixth Edition revised by F. Charles Raphael, M.I.E.E.

This is a collection of essential tables and formulæ in a handy waistcoat pocket size edition for rapid use. It is indispensable to all engaged in heating, power and lighting work and to students of electrical subjects.

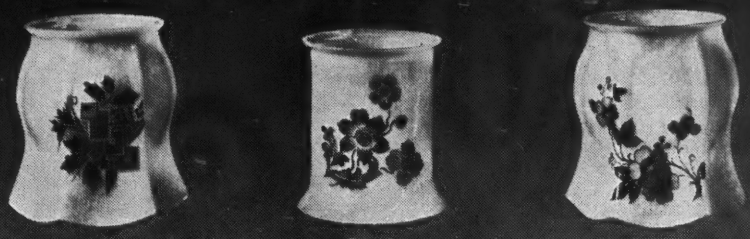
3s. 6d. net.

Order from a bookseller, or direct from
PITMAN, Parker Street, Kingsway, London, W.C.2

Special Lighting at the Albert Hall

The lighting of the Royal Albert Hall, arranged by the Strand Electric and Engineering Co., Ltd., on the occasion of the recent Ford Motor Exhibition, presented a striking example of modern commercial publicity by the aid of light. In addition to increased illumination of the box fronts, intense flood-lighting was applied to an enormous painted back-cloth of futuristic design, suspended in front of the grand organ. Colour-mixing was effected by means of a motor-driven dimmer. This coloured light, impinging upon the coloured pigments of the painting, produced very striking variations.

NEW AND ATTRACTIVE DECORATIONS NOW AVAILABLE



The new designs shown above must be seen in actual colours for their artistic charm to be appreciated. They are essentially modern in taste and will find a ready sale to discriminating gaslight users. We can supply from stock.

VITREOSIL

HEAT-PROOF GAS GLOBES

ENTIRELY BRITISH-MADE BY

THE THERMAL SYNDICATE LTD., VITREOSIL WORKS, WALLSEND-ON-TYNE.

London Depot: Thermal House, Old Pye Street, S.W.1

Mazda Mercra Lamps for 110 Volts

The British Thomson Houston Co., Ltd., has developed a Mazda Mercra electric discharge lamp, suitable for use on 100-110 volt. circuits, which will be available in both 400-watt and 250-watt sizes. The external appearance and operation of the new low-voltage lamps are similar to those of the standard 200-250 volt lamps. There are no extra circuit complications of any kind.

We learn that fifty-two of the B.T.H. Mercra "H" lanterns are being adopted in Bromford-lane, Birmingham, an important arterial thoroughfare. We understand that this installation of the new horizontally burning lamps has led to remarkably even road-brightness.

Edinburgh and Oldham: Public Lighting Appointments

We understand that Mr. R. Beveridge, on retirement from the position of Inspector of Lighting and Cleansing in Edinburgh, is to be succeeded by Mr. Norman G. Wilson (who, like his predecessor, is a member of the Association of Public Lighting Engineers). In Oldham a change has likewise been rendered necessary owing to the death of Mr. I. H. Massey, recently recorded in our columns. Mr. Massey has now been succeeded by his assistant, Mr. Charles Worswick, who joined the distribution staff of the Corporation Gas Department about twenty years ago, and has acted as Mr. Massey's assistant ever since the organisation of the Lighting Department as a separate entity in 1924.

IMPROVED CONTROL FOR STREET LIGHTING

Automatic — no maintenance

RADIOVISOR

'LIGHT ACTUATED' APPARATUS

Adaptable for

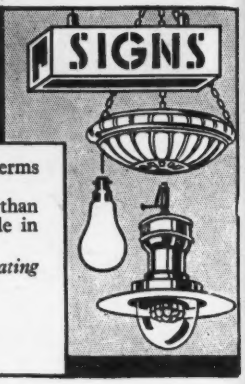
A. C. or D. C. on standard voltages · Reduced Price

Fully illustrated leaflet from

RADIOVISOR PARENT LTD
28 LITTLE RUSSELL STREET
LONDON, W.C.1

Telephone: Holborn 2986
Telegrams: Radivisor, Westcent, London

·WHERE TO BUY·
A DIRECTORY OF LIGHTING EQUIPMENT



We invite applications for spaces in this new section of the journal. Particulars of terms for each space (approx. 1 inch deep and 3½ inches wide) are given below.

These terms are equivalent to **half our ordinary advertising rates,** but not less than 12 successive monthly insertions can be accepted on this basis, and amounts are payable in advance.

Payment for an advertisement in this section entitles the advertiser to receive *The Illuminating Engineer* during the period of the contract.

Terms:	12 Successive Monthly Insertions	£3 10 0	Payable
	24 " " "	£6 0 0	in
	36 " " "	£8 10 0	Advance

1

MODERN LIGHTING FITTINGS
New Catalogue on application
Fittings manufactured to Architects' Specifications
ASCOG LIMITED
Ascog House, 44, Theobalds Road, LONDON, W.C.1

2

PHOTOMETERS
for testing candle-power and illumination. Benches, Cubes, Heads, Standards of Light, Special Fittings and Accessories.
ALEXANDER WRIGHT & CO., LTD.,
1, Westminster Palace Gardens, Artillery Row, Victoria St., London, S.W.1

3

ALLOM BROTHERS LTD.
16, GROSVENOR PLACE, LONDON, S.W.1.
Specialists in the Science of Modern Lighting, including :
Theatres and Public Halls. Tennis and Racquet Courts.
Pictures and Picture Galleries. Floodlighting, etc.
Decorative Fittings in Glass and Metal.

4

BENJAMIN
PLANNED LIGHTING
You get the benefit of over twenty years' experience in the science of Commercial & Industrial Illumination when you specify Benjamin.
THE BENJAMIN ELECTRIC, Ltd., TARIFF ROAD, N.17

5

BROMFORD
Seamless Steel Lighting Standards.
Traffic Signals. Guard Pillars
for all requirements
BROMFORD TUBE CO., LTD., ASTON, BIRMINGHAM

6

THE REINFORCED CONCRETE LAMP COLUMNS SPECIALISTS.
CONCRETE UTILITIES, Ltd.
WARE, Herts.

7

DAWSON REFLECTORS
Indoor and Outdoor Floodlights
JENA REFLECTOR FITTINGS
Miss E. H. DAWSON & HENCKEL,
42, Gray's Inn Road, London, W.C.1.
Telephone: Chancery 8801.

8

Specialists in
ARCHITECTURAL ILLUMINATION AND DESIGNS
DRAKE & GORHAM LTD.
36, GROSVENOR GARDENS, LONDON, S.W.1
Manchester, Glasgow, Hereford and Winchester.

9

ELECTRICITY SERVICES LTD.
Sole Proprietors and Patentees of the "ALL PURPOSES"
TYPERLITE LOCAL LIGHTING UNITS
Write for Price Lists : **86, CANNON ST., LONDON, E.C.4**
Mansion House 5294 (3 lines)

10

"ESLA"
BI-MULTI AND MULTIPLANE REFLECTORS
Lanterns, Brackets, Columns, Switch and Fuse Boxes, etc., FOR STREET LIGHTING
The Electric Street Lighting Apparatus Co.
The Foundry, Canterbury

11

ELM WORKS, LTD.
Established 1903 Summerstown, London S.W.17
Suspension Lamps, Lanterns, **REFLECTORS** for **PUBLIC & INDUSTRIAL LIGHTING**
GAS and ELECTRIC
VITREOUS ENAMELLING Sheet Metal Work, Metal Spinning, &c.

12

INDUSTRIAL LIGHTING SPECIALISTS
Cast Iron Columns *Street Lanterns*
Fuses *Winches*
Time-Switches *Contact Gears*
ELEC Co. Ltd.
ENGINEERING & LIGHTING EQUIPMENT COMPANY LTD.,
ST. ALBANS, HERTS.

13

LIGHT MEASUREMENT
BENCH, CUBE & PORTABLE PHOTOMETERS
employing light sensitive Photo-cells.
EVERETT EDGCUMBE, Colindale Works, **HENDON, N.W.9.**

14

FARADAY HOUSE TESTING LABORATORIES
All kinds of Lamps, Reflectors, etc., Tested
LAMPS TESTED TO B.S.S. No. 161, 1934
SCALE OF FEES ON APPLICATION TO THE SUPERINTENDENT
66, SOUTHAMPTON ROW, W.C.1

15

EINRAY THE NEW LIGHTING
L. G. Hawkins & Co Ltd 30-35 Drury Lane, London, W.C.2

16

FLOODLIGHTING & FITTINGS
LTD.
294, GRAY'S INN ROAD, W.C.1
Manufacturers of "FLOOD" Units
Specialists in Modern Lighting Fittings
Telephone: TERMINUS 5954.

Model "B"

17

FOSTER & PULLEN Ltd.

make all types of Lanterns for Street Lighting
BY GAS

Samples for trial willingly sent—we invite comparison on both cost and quality

AVIL WORKS **BRADFORD**

18

GOWSHALL

MINISTRY OF TRANSPORT ILLUMINATED ROAD SIGNS AND GUARDIAN ANGEL GUARD POSTS LAMP COLUMNS, ETC.

Gowshall Ltd., 49, Theobald's Road, London, W.C.1

19

THE GUNFIRE (Trade Mark)

PIONEERS of AUTOMATIC LIGHTING

GAS CONTROLLERS, ELECTRIC, and SYNCHRONOUS TIME SWITCHES

Manufactured by:—
BRITISH, FOREIGN AND COLONIAL AUTOMATIC LIGHT CONTROLLING CO., LTD., BOURNEMOUTH.

20

CONTROLLED LIGHT

Laylights, Cornice and Pillar Lighting. **G.V.D.** *Pendant Fittings and Standards.*

ILLUMINATORS, LTD.

ALDWYCH HOUSE, LONDON, W.C.2. **Holborn 8879.**

21

"HAILWARE!"

BRITISH MADE ILLUMINATING GLASSWARE AND FITTINGS, TRAFFIC GLOBES AND SIGNS, ISLAND COLUMNS AND FOOTLIGHTS.

HAILWOOD & ACKROYD, Ltd.

BEACON WORKS, MORLEY, Near LEEDS.

Branches and Showrooms:
71/75, New Oxford St., London, W.C.1. 314a, St. Vincent St., Carlton Chambers, 28, High St., Birmingham. [Glasgow.
Ulster Agents: **Messrs. Bell & Hull, 17, College Street, Belfast.**

22

Holophane Elverton St. London SW1

Specify

HOLOPHANE

(Scientific Illumination)

ELVERTON ST., LONDON, S.W.

for

STREET CHURCH INDUSTRIAL
CINEMA FLOOD SCHOOL, Etc.

23

KANDEM ELECTRICAL LTD. 711 FULHAM RD. LONDON, S.W.6.

EQUIPMENT
for
INDUSTRIAL, COMMERCIAL, STREET AND RAILWAY LIGHTING, FILM STUDIOS, PHOTOGRAPHY, PRINTING, ETC., —SUPERIOR QUALITY AND DESIGN—

24

LINOLITE *(Regd.)*

FOR ALL SURFACE LIGHTING.

25

London Electric Firm Croydon

Winches, Lamp Lowering and Suspension Gear, Searchlights *(largest and smallest in the world)*, Mirrors, Lenses, Carbons, Floodlights, Flexible Couplings (all-metal), Wire Ropes, Headlights,

Street Lamps, Poles, Reduction Gears, Signal Lamps, Flashing Shutters, Cable Drums, Guide Pulleys, Electric Irons, Kettles, Fires, etc., etc.

On War Office, Admiralty, Air Ministry, Post Office, etc., etc., Lists.

26

MEKELITE

FOR CLOSE-UP LIGHTING

ADJUSTABLE FITTINGS FOR EVERY USE.

MEK-ELEK ENGINEERING LTD., 16, Douglas Street, LONDON, S.W.1

27

"THE MILNE"

SELF-CONTAINED PORTABLE FLOODLIGHTS

CONTRACTORS' TRAFFIC SIGNALS, AND HAND-LAMPS

C. S. MILNE & Co., Ld., Octavius St., DEPTFORD, S.E.8

28

Floor Standards, Ceiling Pendants, Wall and Corner Brackets

MONOLAMP

Modern Indirect Fittings

308, REGENT ST., W.1
and 47, Victoria Street, S.W.1

Silver Glass Reflectors and Metal Spinnings

TELEPHONE: LANG. 2817. *GOLD MEDAL—PARIS, 1931.*

29

W. PARKINSON & CO

PROMOTERS OF SCIENTIFIC STREET LIGHTING BY GAS

Our Research Lighting Bureau will solve your problems

IRON LANE · STECHFORD · BIRMINGHAM

Tel. No.: Stechford 2256. And at London and Belfast

30

RADIOVISOR PARENT LTD.

28, LITTLE RUSSELL STREET, LONDON, W.C.1

Specialists in Light Actuated Apparatus

AUTOMATIC CONTROL of STREET and FACTORY LIGHTING

No maintenance costs—Applicable to both A.C. and D.C. Supplies

Phone: Holborn 2986

31

SIEMENS

38-39, UPPER THAMES STREET, LONDON, E.C.4

ELECTRIC LAMPS of all types. ELECTRIC LIGHT FITTINGS. FLOODLIGHTING APPARATUS. SHOP-WINDOW LIGHTING EQUIPMENT. STORE LIGHTING. INDUSTRIAL LIGHTING. CINEMA LIGHTING, ELECTRIC SIGNS, Etc.

32

PHOTO-ELECTRIC CELLS

Selenium Layer Type (Brit. Pat.) round or square, for all kinds of light-sensitive apparata.

STAFFORD & LESLIE,

ARMOUR HOUSE, ST. MARTIN'S-LE-GRAND, LONDON, E.C.1

Tel: National 5025

33

STRAIGHT-LITE REFLECTORS, LTD.,

73, CANONBURY ROAD, LONDON, N.1

Write for List No. 44. *The latest publication on*

SUPER STRAIGHT-LITE, THE MODERN SYSTEM OF SHADOWFREE ILLUMINATION FOR MAXTRIP "2" LAMPS

34

STRAND ELECTRIC

AND ENGINEERING CO., LTD.

19-24, FLORAL STREET, LONDON, W.C.2

Specialists in Modern Theatrical Lighting

Manufacturers of "Sunray" Lighting Equipment
Electrical Installation Contractors. Lighting Schemes for

Theatres Floodlighting Exhibitions Cinemas Pageants
Shop Windows Dress Parades Ballrooms Tea Lounges

35

For every type of GAS LIGHTING

SUGG WESTMINSTER

When you want the best!

CHAPTER ST. S.W.1

36

ULTRALUX

LIGHTING FITTINGS

TROUGHTON & YOUNG LTD

143 KNIGHTSBRIDGE

37

WARDLE ENGINEERING Co., Ltd.

OLD TRAFFORD, MANCHESTER

STREET LIGHTING EQUIPMENT. TRAFFIC SIGNALS
PRISMAT BULKHEAD FITTINGS. FLOODLIGHT PROJECTORS
WORKSLITE REFLECTORS. WARDELYTE GLASSWARE

38

"THE FITTINGS THAT IMPROVE WITH AGE"

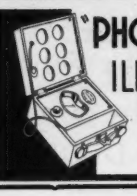
WOODFYT

(WOOD ELECTRIC FITTINGS)

10a, NEWMAN STREET, W.1

(Museum 7325)

Catalogue sent on application



"PHOTRONIC" Photo-electric ILLUMINATION METERS BY **WESTON**

39

40

For terms and particulars of advertisements in this section see top of Page 28.

Index to "Where to Buy"

The continuous increase in the number of entries in the Directory of Lighting Equipment ("Where to Buy") suggests that the accompanying subject index, introduced for the first time in this number, may prove useful to readers. Entries in the Directory are made alphabetically and are now also numbered. The new subject index indicates the numbered entries dealing with any particular form of apparatus or system of lighting. Readers can thus see at a glance where to turn for information on some particular subject. Naturally the index is not exhaustive and only deals with the chief items in existing entries; it will, however, doubtless tend to become continually more complete as additional entries for the Directory are received.

Architectural Lighting	8
Automatic Light Control	19, 30
Concrete Pillars, etc.	6
Electric Lamps	31
Film Studio Equipment	23
Fittings	1, 3, 4, 15, 16, 20, 21, 23, 24, 28, 31, 36, 38
Floodlighting	16, 25, 27, 31, 34, 37
Gaslighting	17, 29, 35
Glassware	21, 22
Guardposts	18, 21
Industrial Lighting	4, 12, 37
Local Lighting	9, 26
Photometers	2, 13, 32, 39
Reflectors	3, 4, 7, 10, 33, 37
Signal Lights	25, 27
Special Lighting	3, 20, 21, 23, 24, 31, 34
Steel Standards	5, 25
Street Lighting Units	10, 12, 17, 29, 37
Testing Laboratories	14
Theatre Lighting	34
Time Switches	19
Traffic Signs	18, 21
Winches	25

N.B.—The numbers are those attached to individual entries in the Directory (See pp. 28-30).

G.V.D. Illuminators, Ltd.

Readers will be interested to learn that owing to the rapid growth and expansion of the business founded by Mr. G. V. Downer, and known as G.V.D. Illuminators, a private limited company of the same name has been formed to take it over and to carry out all future orders and contracts. Mr. G. V. Downer is the managing director and chairman of the Company, so that continuity of management is assured.

Radiovisor Specialities

The use of the Radiovisor Light-Sensitive equipment for the automatic control of street and factory lighting is now familiar, but other applications of the apparatus are less well known, notably its application in the Radiovisor Counting Unit, and its use in testing the turbidity of solutions, etc. Several interesting leaflets dealing with these topics have been recently isued by Radiovisor Parent, Ltd.

Credalux

Industrial, Commercial & Street Lighting Shopwindow

REFLECTOR FITTINGS

SCIENTIFICALLY DESIGNED

SIMPLEX ELECTRIC CO., LTD.

Head Office: 159, GREAT CHARLES STREET, BIRMINGHAM, 3

"LUX"

(La Revue de l' Eclairage)

WE have pleasure in announcing to our readers that we have entered into an arrangement to receive subscriptions for the French Journal "Lux" (La Revue de l' Eclairage). The subscription per annum is 30 francs, the approximate equivalent of which in English money is Seven Shillings and Six Pence (7/6).

"Lux" is the only French journal which specialises in all aspects of lighting, it is the official organ of the Association Francaise des Ingenieurs de l' Eclairage (equivalent to the Illuminating Engineering Society in France).

It furnishes a complete record of interesting developments in lighting in France and on the Continent. It is fully illustrated and in particular devotes a considerable number of its pages to Decorative Lighting.

By studying these articles and the numerous photographic reproductions of modern lighting installations the reader can readily gain an excellent impression of French methods and practice in matters of Illumination.

Applications for subscriptions will be received by "The Illuminating Engineer," 32, Victoria Street, London, S.W.1.

B

A "Class A" Installation for BIRMINGHAM

IT was resolved to provide conditions of illumination corresponding to "Class A" of the British Standard Specification by means of high pressure gas lamps suspended over the carriage way by wire cables spanning the street and attached to buildings on each side. The respective widths of the carriage ways in New Street and Corporation Street are 35 ft. and 40 ft. Pairs of lamps, each yielding about 3,000 c.p., are mounted in pairs, 7 ft. apart, and spaced at intervals of 70 ft. The height of lamps above the surface of the roadway is 26 ft. 6 in.

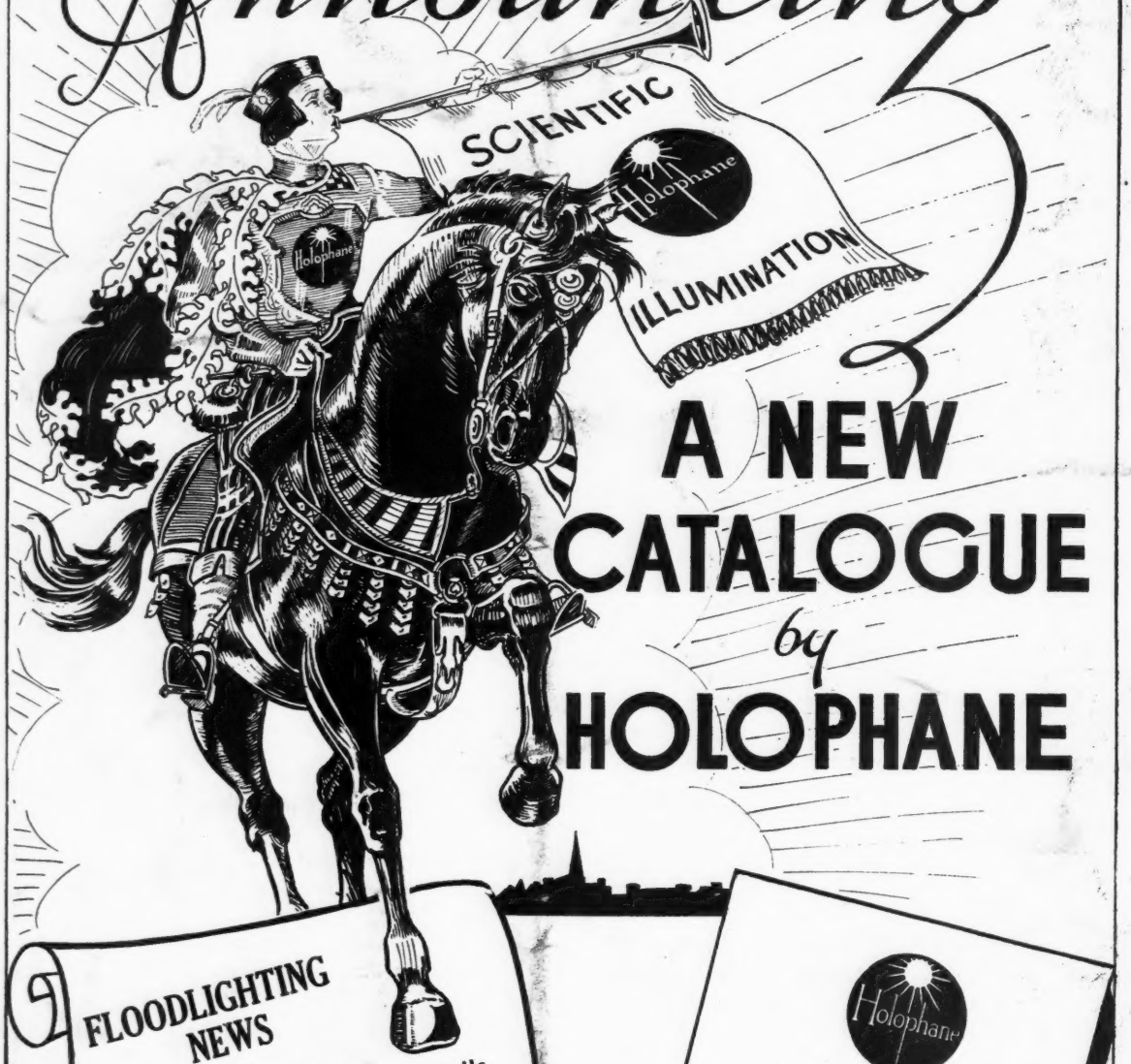
With acknowledgments to the "Illuminating Engineer"

Corporation Street, Birmingham, under the new system of Gas Lighting.

New Street, Birmingham, under the new system of Gas Lighting.

BRITISH COMMERCIAL GAS ASSOCIATION, 28 Grosvenor Gardens, London, S.W.1

Announcing



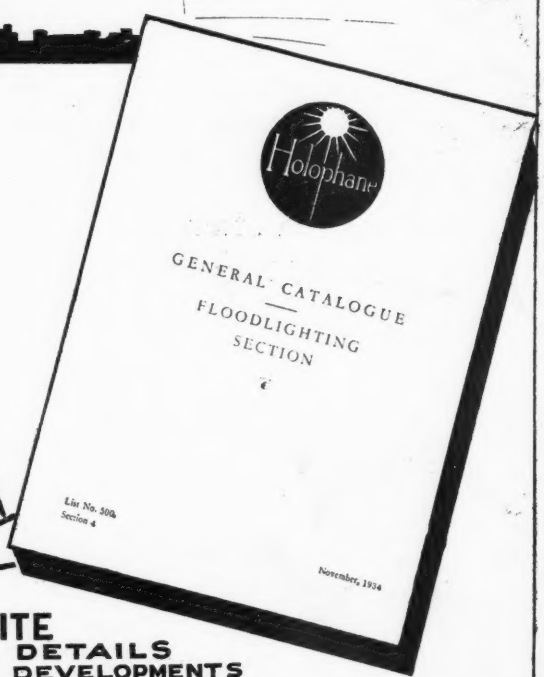
A NEW CATALOGUE by HOLOPHANE

FLOODLIGHTING NEWS

The new Holophane Floodlighting List gives full details of many additions to the range of units available.

THERE IS A UNIT TO SUIT EVERY MODERN REQUIREMENT.

This new catalogue contains illumination engineering data for planning floodlighting schemes that should be studied by all interested in this subject.



WRITE FOR FULL DETAILS OF THESE NEW DEVELOPMENTS

HOLOPHANE LTD. 1, ELVERTON STREET, VINCENT SQUARE, LONDON, S.W.1

Grams: 'Holophane, Sowest, London' Phone: Victoria 8062 (3 lines)

Printed by the Argus Press, Ltd., Temple-avenue and Tudor-street, London, E.C.4, England.